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THE AMERICAN, AND THE GERMAN, "PERIL."

By Louis J. Magee.

I. THE INTERCHANGE OF EXPERIENCE BETWEEN NATIONS.

Mr. Magee's close association with some of the largest financial and industrial interests active in Germany and America gives him a peculiar insight into the commercial ideals of the two countries. His intimate personal acquaintance with the life and the social conditions in both lands fits him to see far beneath the surface, and to interpret each to the other with the insight possible only to a friend. But he writes throughout, as will be noticed, from the standpoint of an earnest, broad-minded, and deeply loyal American.

This introductory article will be followed by two more—the second dealing with "Differences and Contrasts in National Traits and Industrial Policy," and the third with "American Trade Methods Tested by German Experience." In view of the great and rapidly rising importance of Germany's position and aspirations as a world power in manufacture and commerce, and of the particular activity of interest in her future relations with the United States, these papers will be of great significance and, we trust, of real public value. —THE EDITORS.

THE curve traced by a nation's periodic "ups and downs" is in Germany's case approaching a new "peak." That people's commercial ascendency in Europe finds its analogy at another high part of the long curve four to six centuries earlier—the proud Hansa times. The Hanseatic League was a successful mediæval "Trust" formed in defiance of robber knights and Danish pirates, to make business safe and systematic in an Empire where there was no other community of interest, no order, and no protection for the "common merchant." This league of cities gained for its members a monopoly of practically all the products of Northern Europe, reached far into the Mediterranean countries, and, from its stronghold in London, the "Steelyard," laid a controlling hand on the trade of unawakened England. Its organization was efficient, its rules strict. Those early merchants developed a wonderfully practical system of

distribution, warehousing, and exchange. The tapestries of Flanders, Rhenish wine, Skâne herring, Hamburg beer, English wool, and the furs of Novgorod—every luxury and necessity—was theirs alone to carry and to sell. But as a statesman long before our times has said, "the weak point of the League was that it had no backing of manufacturing interests." Today, however, German traders have a mighty home industry behind them; this is a serious combination.

Contrary to our ideas of crowded Europe, all but 9.3 per cent of the territory of the Empire consists of farms, forests, vineyards and moorland. About 18,000,000 of the population gain a living from agriculture, gardening, cattle raising, forestry and fisheries. But it is the 9.3 per cent town territory which we hear of in the outer world. There are 178,936 factories with 3,822,959 operatives. The labor conditions are considered comparatively favorable, although as many as 1,400 strikes take place in one year. The industries are frugally managed, and the quality of plant averages high. Raw materials are comparatively free from duties.

The accumulated business experience and routine of centuries, on the one hand; and the high scientific attainment, tremendous technical activity, and unsurpassed schools, on the other hand, combine to warrant the German manufacturers and exporters in expecting much for the future. They are, however, handicapped by a dearth of raw material, a very small home market, and by jealous particularism within the Empire; by strong national preferences, and in some cases high customs duties, among their neighbors. America's growing interest in the markets of the world has also of late become a new source of anxiety. The modern German business man reads the signs of what Americans may do when they seriously look abroad for business. He notices their growing strength and restlessness. "The American Peril" has become a newspaper phrase.

Europeans have, to be sure, for years invested in our railways. They have purchased our food stuffs and sent us manufactured goods that we could not make ourselves. Midway in the 80's, sewing machines and Mauser rifles were being built in Europe on the American system of interchangeability of parts and measured with gauges from Providence. Several factories were even then equipped with American tools. But despite all the points of contact, most leaders of European industry, finance, and politics left America, until very recently, out of their daily calculations. To-day it is the fashion in high business circles to be informed on things American. Especially Germany, which provides about three-quarters of all Continental initi-

ative, is very seriously concerned in finding out what she can do to improve along American lines.

There are several definite causes which have combined to make America the new idea in Europe. Only recently have our promoters and capitalists had any large interests in the Old World. For example, see Mr. Yerkes' mastery of the London transportation problem, or the electrical, radiator, and air-brake factories built in England and on the Continent, largely with American capital and technical assistance. Our promoters however have only begun to look abroad. They are still too much occupied at home. American manufacturers likewise have only of late attacked the European markets systematically. Sometimes good things sell themselves, and for years ours did that. We are just learning the niceties of the export business, and just creating a market for such of our wares as must have their advantages proven by organized effort. A third cause of new interest in Yankee intentions was the formation of the United States Steel Corporation and the Shipping Combine and other trusts. These made a deep impression upon the *haute finance* of Europe. "Herr Pierpont Morgan" was abused in many languages. The Banks of Germany, contrary to the custom in this country, participate in the ownership, and have much to say regarding the management, of the iron works, rolling mills, shipyards, ocean lines, collieries, and electrical companies, so that their directors have very receptive minds for all that affects the great industries. Another cause for interest is the increasing importance of Wall Street in the money markets of the world. The personality of our President also is engaging the attention of all Europe. And still another cause of Germany's interest in our country, comes from the Emperor himself. Quite aside from the value of Prince Heinrich's visit, and the annual social amenities of the Kiel yachting week, in which American millionaires figure prominently, Kaiser Wilhelm is kept informed constantly by his own "Captains of Industry" gathered about the round table with their cigars. The German Emperor is tireless in educating himself. He is catholic in tastes, generous in encouraging those of his people who "do things," and full of initiative toward improvement

The Emperor's intimate acquaintance with the industries, kept up in parallel with his necessarily heavy burden of fiscal military, and naval detail, is a matter of every-day satisfaction to the Germans.*

* "Strangely the old and new are combined in Kaiser Wilhelm; the romantic and the modern. Yesterday he was exhibiting inflexible absolutism; today he shows a deep understanding for the demands and the needs of the time."—*Tageblatt* editorial on Emperor's speech at opening of Danzig Technical University.

His creation of the degree of Doctor-Engineer was the official recognition that technics have become an essential element of modern culture. This raising of the technical profession to an equality with the other officially approved professions, in a country still hampered by bureaucracy, was an act of no little significance. Appreciating at once the marvellous rise of America's power, William II has insisted vehemently in all directions upon a more careful study of American "equipment." The visit to the United States of his Minister of Finance, accompanied by the proprietor of a steel works, was symptomatic of the Emperor's anxiety to have his best men acquainted with us. It has been followed by hundreds of other visits.

Mr. Frank Vanderlip, in 1901, published a series of articles entitled "America's Commercial Invasion of Europe." In New York a reprint fell into the hands of Count Tiele-Winckler, a favorite of the Emperor and owner of large mining and industrial properties. Upon his return home he showed the articles to His Majesty, and also caused them to be translated into German and privately printed. The Vanderlip "brochure" is responsible for not a little awakening and self-examination in German speaking Europe.

The mass of the people, in Germany at least, influenced by extravagant and misleading notices in their newspapers, still think of us as "The Dollar Land," the country of freaks and plutocracy. We have not as yet had time to impress Europe with the quality of our intellectual contingent. Our colleges and churches, our libraries and our literature, have excited little attention abroad. We are to Europe first of all intensely practical. Our wealth seems still to be our distinguishing characteristic among the nations. It is truly paradoxical that the German people, themselves famous for commercial attainments, should think of us only as money makers. Wealthy Americans are in fact more public-spirited in the use of their money than Europeans. On neither side of the Atlantic do the real leaders of finance and industry seem to be impelled alone by the love of money. The automatic increase of responsibility which comes with accruing profits, the pride of business and social position, the *noblesse oblige* of *haute finance,* are often the real motive where avarice alone is assumed.

Most visitors flatter us. All unite in admiring the energy and courage which were necessary for such unparalleled development as ours. Quantity, massiveness, volume, in manufacture and movement, surpass even their expectations. They overlook incompleteness of means in admiring the completeness of results; they are overcome by the elemental force, the surge and thunder of our traffic. The long

lines of coal trains on multi-track railroads; the immensity of our farms; the mammoth conceptions in the building art which have given our cities their new physiognomy; our luxurious living; our clubs, hotels, limited trains—all are intensely interesting to them as indicative of, and suited to, conditions which do not pertain in Europe. The generally amiable personality of our people, and cordial frank manner of our business men, seem to be highly appreciated by our guests. The hospitality of our countrymen is praised by them long after they return to Europe. They are astounded at the liberality of our wealthy men in their contributions to public institutions; and some Germans have seen in this load of responsibility for the American millionaire an onus fully equivalent to the high taxes which he would have to pay in Europe. They laud the freedom from enviousness here, which, contrary to European conditions, allows a fuller co-operation of all our economic forces working to one end. Beneath the turbulence of our noisy life, some of our guests find also opportunity to recognize that strong under-current of refinement, broad intellectuality, and keen sense of artistic appreciation which the old countries still claim as their own monopoly.

The German opinion of our financial conditions can be characterized best, perhaps, by the answer of a leading Berlin capitalist, a pioneer in the appreciation of American methods, who was recently offered a participation in an enterprise in this country. He courteously refused it on the ground that American business conditions were at present too *undurchsichtig* (too un-see-through-able). Even those who admire so many American *individuals* and respect the solidity and absolute integrity of so many of our industrial and financial institutions, distrust our methods. They do not confine their distrust to Wall Street; to any great corporations or banks; on the contrary, they know that much of the loss and suffering and disorder has been brought about by careless management of small enterprises, and by small, unscrupulous, *unwatched* promoters close to the people, everywhere throughout the country. The power of the individual in business, which is decidedly more of an American characteristic than European, becomes in their eyes dangerous because uncontrolled. The Germans would see us establish a business organization which shall be uncompromising where individual ethics may be weak and indefinite; something which shall be more continuously restraining, and less impulsively corrective, than popular indignation finding expression in the press. Germans can never quite overcome their surprise that the legal interpretation of what is right and wrong should so vary in our

different States. They deplore our tendency to evade good laws where we have them. United Germany, being made up of States whose traditions were all very deeply rooted, could not easily bring about a uniformity in these matters; but technical and artificial barriers had to go down before the wise recognition that commercial solidity must rest on one rule for all, especially in matters pertaining to business. It is a matter of eminent significance that as long ago as 1848, when the German States were much less intimately bound together than they are today, a uniform law was adopted covering the subject of bills of exchange, and is in force today. In 1861 the business law, essentially as it is today, was also adopted uniformly by all the German States. Both of these laws are also the same in Austria. In 1870 a uniform criminal law, in 1879 a uniform law of court procedure, and in 1900 the admirable Civil Code, came into effect for all the German Empire.

While deploring our present faults, some German financiers look with envy upon the broad interest which the American public take in Stock Exchange transactions, thereby making the New York market so receptive and so able to meet the enormous demands which the development of the industries and railroads has put upon it. In Germany the Government supervision of the Stock Exchange is too rigid, and the stamp taxes on transfers of property are also a serious hindrance to business. In attempting to make popular speculation difficult, they drove away business from Germany to foreign markets. The Government interference has not seemed to be as helpful in this respect as it has in other departments of business.

German criticism is not unfavorable to our trusts. The consolidation of banks and industrial concerns is proceeding steadily in Germany as well as here. They have themselves over three-hundred trusts, "cartels" and "syndicates" (forms of combination for sale of product, or fixing of prices, and regulating of production). They recognize that trusts bring danger and that these dangers would be materially lessened if we had good and uniform corporation laws. A fundamental difference between the trusts in Germany and those in the United States is that owing to enforced publication of statements on the part of all share companies in Germany, it is always possible for the public to approximate closely the value of a trust's real assets, as separated from the profits taken by promoters. This means the publication of the balance-sheet with enough additional information to afford the stockholders (that is, anyone, as shares are not registered) a just estimate of the value of *their own* property.

It does *not* mean the divulging of business secrets, nor the dealing out of personal gossip to a curious and indiscriminating public. A great deal of healthful probing goes on in Germany continually, and behind closed doors. The guardians of the common weal are not expected to function *coram publico*. Germans laugh at us for hanging our affairs onto the "great bell."

As to the various specialists who come to the United States, theirs is the study of details by methods of strict comparison. There are many bases for such comparison, confined largely to American industries and methods of transportation. There are vast enterprises in Germany, quite comparable to our own, which render such comparisons extremely valuable for both countries. The electric railways in Berlin alone, for instance, carried 400,000,000 passengers last year. One German firm manufacturing electric apparatus and machinery has 30,000 employees on its pay roll. By far the highest speed ever attained on a railroad train has been made on a German track. Krupp's is only one of the great steel works. Some of Germany's 4,000 sea-going ships we all know.

The foreign engineers who study our plants recognize many points of superiority, but sometimes they find they are doing certain things as well as we are, or even better. American machinery and shop methods have been preached incessantly now for so long a time in Germany that many German shops do as good work as ours. In a country not so largely supplied with natural riches as the United States, they have applied themselves much more than we have to the increase of mechanical efficiency.

What must most impress one, however, from a consideration of all this inspecting of our works (and I want to testify to the fact that German visitors are very appreciative of our manufacturers' liberality in allowing their works to be seen) is that Germany does send a large number of men in all lines of work to study American conditions. Sometimes the leaders come themselves. Furthermore, they come really *to learn*, and not for vacations or to satisfy their pride. They are intensely objective. They come with the spirit of absorption, of getting either new methods to apply at home or at least a new impulse, a fresh excitation of the nerves of enterprise. We have, therefore, today, in the Kaiser's realm, the spectacle of a nation wisely afraid and quietly strengthening itself for the coming greater struggle. As the Emperor said, "Germany's future lies on the water." So, too, does that of our industrial East. Nations, like men, in growing strong are bound to reach out and expose themselves to new responsibilities.

Imperialism is not a question of policy for either Germany or ourselves. It is the concomitant of efficiency and virility. The Germans, seeing, therefore, what is before them, seem to understand far better than we do the great advantage of learning where and what they can. The Americans, on the contrary, are as a nation likely to be self-satisfied. An important German financier in recounting his American experiences to colleagues at home referred to our national love of praise. He also said: "Although I have been for years in business connection with America and come frequently into personal contact with American business friends visiting Berlin, I found that I had an entirely false idea of the land and people on the other side of the ocean. I can add, that I was quite as much surprised to find so inadequate a knowledge of our land and its inhabitants. In fact, *they seem to know less of us than we do of them.*"

Some of us not knowing the good to be found in other lands have no basis for comparison. Some of us know and do not care. We are, in some respects, afflicted with the spirit of *laisser aller.* We insist on having the best homes, full of comforts; but as soon as we close our doors behind us and pass to the street, a harsh change has taken place. We look with complacency on the public dirt, the unsightliness which is no individual's to alter, and the frequent inadequateness of what is supposed to serve the common good. As a people, we seem content to exercise our business acumen, frugality, and powers of organization in everything *but* public matters. We do not begin to live up to the high degree of technical and scientific enlightenment vouchsafed us in matters pertaining to public health or the avoidance of dangers.

The foreign visitor finds in the United States, as he expects to, refinements and luxuries on a scale to which he is unaccustomed. He is, therefore, the more surprised to find the clever, wealthy Americans putting up patiently with conditions which western Europe now considers antiquated. The disorder of street traffic; the nuisances and obstructions which are allowed to gather; the sweepings and refuse blowing about from coverless refuse carts; the dry sweeping of the streets; the accumulation of snow; the miserably inadequate gas lighting of some of our best residence streets just off the main avenue; the cab without a taxameter; the insufficiency of the police; the prevalence of crime; the lack of discipline so often apparent; the crying frequency of railway accidents—these features always surprise our guests. Fortunately we are beginning to understand that we have much that requires vigorous overhauling. Our President, too, has

been doing what the public conscience without strong leadership might not have done for years to come. In the changes which are before use we are coming to exactly the same problems which the older countries have had to work out. Day after day our public men are proposing methods for which we might as well have the details from Europe, for most of them have been tried there.

In attacking every new problem and discussing every new proposal we are likely to find most valuable experience awaiting us on the other side of the ocean, if we will only ask for it. We could learn much from abroad in road building, municipal engineering, the improved handling of passengers' luggage, safety and hygiene in railroad and steamer travel, cab service, the inspection of buildings and ships, custom-house methods, forestry, trade schools, corporation laws, the registration and control of servants, workingmen's insurance and pension, safety and cleanliness in factories, export business methods, and scores of other particulars.

In various branches of our public service we can point to individuals who are of unquestionable integrity and equal, if not superior, intellectually, to their European *confrères.* These *individuals,* however, seem to lack the backing of an interlocking *organization.* Their good ideas are taken or refused by a public which has neither the training nor opportunity to learn in detail what is best for its own interests. The Germans have secured a certain degree of permanency for those offices where specific experience is absolutely necessary for guarding the people's interests. German mayors are mayors by profession. They begin in small towns and are called to large cities if they distinguish themselves. They gather experience and ultimately master the problems of municipal administration. Not only the mayors, but the aldermen who supervise such specialties as the care of orphans, poor and insane, and matters pertaining to public health, hospitals, etc., have long careers in which they amass and wield valuable knowledge for the public good. The city engineers are practically sure of permanent positions if they are masters of their work They are given every opportunity to study the works of other cities and even allowed to advise on similar work in foreign countries. The city engineer of Berlin has just presented plans for extensive warehouses and tunnel work, but before preparing these plans he visited dozens of warehouses, grain elevators, inland harbors, and all the subways in the United States, England and France.

If they have few destructive fires and few unhealthful districts or unsafe buildings, few disfigured streets and burglaries, it is not

because the German *individual* is so careful, reasonable or good, but simply because he must subordinate himself to the distates of a *mighty, and permanently incorporated, sense of public guardianship.*

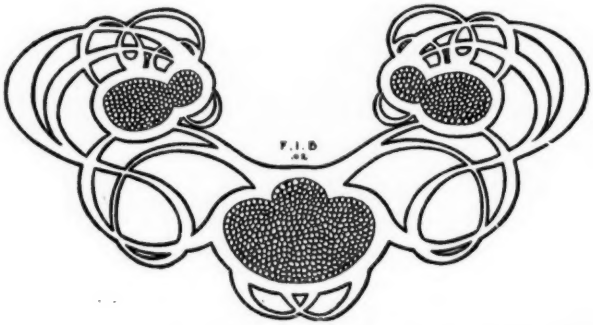
Many of our good citizens delay reform by deprecating any word of criticism. They constantly assure us that we will work out our own salvation by a natural process of development. In *business,* however, we do not wait for natural development. There we compel results; we reject and select until the product and the methods are beyond criticism. Why not apply the same attitude of thought in all things regarding which we are open to criticism, from our own, as well as foreign, observers?

Every wideawake American who has anything to manage, from a machine shop up to a Department of State, may improve his results by making it a part of his duty to know how the same work is done among other successful peoples.

Supplied as we are with the Earth's riches, free in action, and with blessed traditions to guide us, we cannot afford to neglect our competitor's strong points. It requires eternal vigilance and self-recognition really to become what we are not yet, an American Danger.

We may all say with mediæval Gerard:

> "This then have I, Sir Footsore, learned, that each Nation hath its proper wisdom, and its proper folly, and methinks could a great king, or duke, tramp like me and see with his own eyes, he might pick the flowers and eschew the weeds of Nations."



AUSTRALIAN COAL PILED NEAR MAGELLAN'S MONUMENT, SOUTH SIDE OF THE PASIG RIVER.

The view is just outside of the "walled city," Manila, and shows coasting steamers and quartermaster's launches in the river.

UNITED STATES ENTERPRISE IN THE COAL TRADE OF THE PHILIPPINES.

By Oscar Halvorsen Reinholt.

Mr. Reinholt was Superintendent in Charge of Exploration, U. S. Government coal mines, Albay province, Philippine Islands, in 1903 and 1904. He was in direct charge, therefore, of the developments described in the following pages. His definition of the possible economic importance of the deposits is clearly put in his introduction, and needs no restatement. The photographs from which the illustrations are reproduced, with the exception of two small views specially credited on pages 507 and 511 were taken by the author.—THE EDITORS.

NOTWITHSTANDING all the public interest displayed in proposed Government ownership, or control, of certain materials and services, little or nothing has yet been published in the United States about the first attempt of the Federal Government to develop a source of fuel supply for a part, if not all, of its own demands. That attempt began in earnest thirty months ago, when First-Lieutenant Hubert L. Wigmore, aide-de-camp to General Davis, was placed in charge of this important undertaking by the Secretary of War, and the writer, a civilian mining engineer, was detailed by Governor Taft to assist the above named officer of the Corps of Engineers. The site selected was in the Philippines where, fortunately,

the economic conditions are very favorable, inasmuch as nothing in the shape of a private coal-mining industry is there established to antagonize.

Uncle Sam is not, however, the first among nations to initiate so important a step. The Governments of at least two British colonies have for several years made serious efforts to supply themselves with mineral fuel from their domestic deposits. Since 1901, Cape Colony* has been trying to purchase, or to find and develop, a coal mine primarily for the needs of the Government railroads. New Zealand,† long noted for the application of advanced theories in political economy, has now succeeded in opening two coal mines, avowedly to make the colonial railways independent of private production of fuel, and to regulate prices of coal by unloading the surplus product upon the market whenever desired.

For some years past the government of the Dutch East Indies,‡ famous for the "culture" system of raising revenue, has met a large part of its requirements in coal through the operation of state collieries on the island of Borneo.§ The Servian State Railway now actually controls about half the output of mineral fuel in that little European country. Even in conservative Germany, the Governments have their eyes open to the advantages gained by possessing coal properties of their own, especially where the railroads are under the ownership or direct management of the state. Thus the Kingdom of Prussia recently made overtures to the Westphalian Syndicate, though without success, for the acquisition of collieries in the great Ruhr coalfield from which the State railways might obtain the necessary combustible. The instances cited are all of Government enterprises in the old world, and they well imply the intimate relation of coal mines to steam railways.

On the American continent there are, to my knowledge, only two countries whose governments have decided to embark in the business of coal-mining. They are Venezuela and the United States of Colombia, both of which bear some natural resemblances to the Philippines, not the least important being the possession of unexploited mineral resources, particularly coal and lignite.

The coal consumption of the Philippines is as yet relatively insig-

* "Report on the Mining Industry of Natal for 1902," pages 16, 17 and 73.

† "Papers and Reports Relating to Minerals and Mining in New Zealand," 1904, and *The Engineering and Mining Journal* of October 27, 1904.

‡ "The Mineral Industry for 1903," published by *The Engineering and Mining Journal*.

§ "English Statesmen's Yearbook," 1904, page 115, states that the Rajah of Sarawak has a monopoly of coal mining in Brunei, British Borneo.

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RAILWAY TRANSPORT IN THE PHILIPPINES. TRAIN ON THE MANILA-DAGUPAN LINE.

The railway—about 125 miles long—has been for many years the only steam road in the Islands. Its fuel consumption makes but a small percentage of the coal used in the Philippines.

nificant, owing chiefly to a warm climate, a small railway mileage, and a backward state of manufacturing industries. Although the total consumption has nearly quadrupled in the course of the past ten or twelve years, and now approximates 400,000 tons per annum, including all purchases of the War Department on account of the Philippines, the amount used per capita is still ridiculously small, averaging of late not much more than one-twentieth of a ton each year. Compared with the Philippines, Japan has a per-capita consumption of coal three times as great, Australia twenty-seven times, Belgium nearly sixty times, and the United States over eighty times as great. Even in South America, most of the countries surpass the Philippines in this respect. But in China, where the coal deposits are considered to be the most extensive in the world, the quantity of coal used per inhabitant is probably not one-tenth of that in the Philippines.

The coal consumed in the Philippines is practically all imported. It may be safely ventured that in no year hitherto has the local yield reached a record of 10,000 tons, and that may therefore be disregarded

NATIVE TRANSPORTATION BY LAND IN THE PHILIPPINES.

A single *carabao* or water buffalo usually draws the *carretón*—rarely a team of two or three. The load in the picture is *abacá*, or Manila hemp—the chief product of southeastern Luzon and of the Visayan islands (Cebu, Leyte, Bohol, and Samar).

NATIVE WATER TRANSPORT. A BARROTE ON THE GULF OF ALBAY.

A "dugout," for minor use, is seen behind the fish corral. The outriggers of the *barrote* are made of bamboo.

as a factor of importance at the present time. Coal is utilized in these islands almost entirely for steaming purposes, mainly on board vessels near Manila and in inter-island transportation. The Government, inclusive of the civil as well as the naval and military branches, disposed of 60 per cent of the imports in 1903, the United States Army alone taking 35 per cent. While the latter was formerly the leading consumer, it has now dropped to second place with the passing of active warfare from the islands.

In 1903 the general public consumed 40 per cent of the imports, compared with 35½ per cent in 1902 and hardly 30 per cent in 1901.

MAYON VOLCANO, ALBAY PROVINCE, SOUTHEASTERN LUZON.

Height, 7,916 ft. While not the highest, it is probably the most frequently active of the twenty active vents reported in the Philippines. Dr. Becker says: "It is possibly the most symmetrically beautiful volcano cone in the world." "The vertical outline is the hyperbolic sine curve." View taken from Legaspi during high tide, by the author.

This increase was a natural consequence of peace conditions which have prevailed for more than four years. The United States Navy, which ranks as the third consumer, has depended quite exclusively upon the excellent Pocahontas steaming coal from West Virginia, to the extent of from 14 to 20 per cent of the annual imports during these three years. The Civil Government, while yet the least important, has increased its takings at the greatest rate of the four consumers.

TABLE OF IMPORTS OF COAL INTO THE PHILIPPINES, IN LONG TONS, ARRANGED ACCORDING TO THE SOURCES OF THE SAME, 1901-3.

Origin of Imports.	1901.	1902	1903.	Three Years.	Leading Consumer.			
Japan	275,761	180,186	159,257	615,204	Army	81.7	per	cent.
Australia	78,948	90,949	161,074	330,971	Public	86	"	"
United States	59,179	70,514	72,156	201,849	Navy	94.5	"	"
United Kingdom.	1,231	7,648	Nil	8,879	Public	100	"	"
Germany	2,778	7	Nil	2,785	"	100	"	"
British India	46	897	Nil	943	"	100	"	"
China	218	29	129	376	"	100	"	"
All others	499	406	432	1,337	"	100	"	"
Total.....	418,660	350,636	393,048	1,162,344	Army	44.2	"	"

TABLE OF PERCENTAGES CONTRIBUTED BY THE TWO LEADING SOURCES OF COAL IMPORTED INTO THE PHILIPPINE ISLANDS.

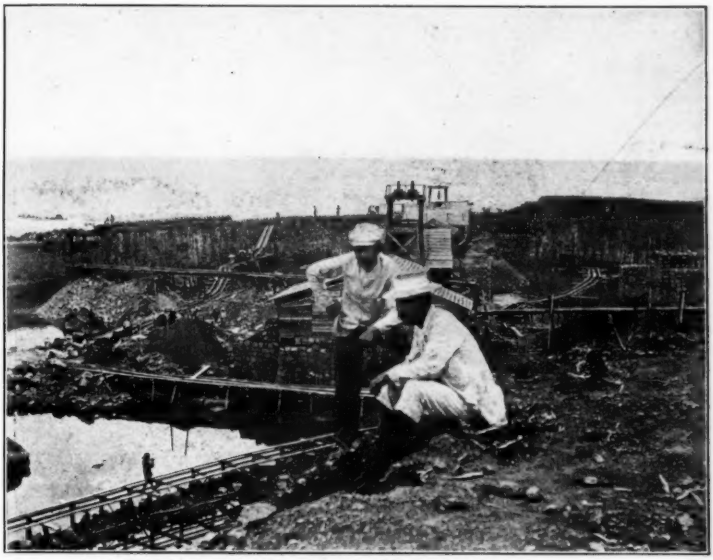
	1901.	1902.	1903.	Three years.
Japan	65.9	51.5	40.5	52.9
Australia	18.9	26.0	41.0	28.5
Total.....	84.8	77.5	81.5	81.4

As regards the sources of the fuel, it appears that the Orient supplies nearly five-sixths, the other sixth originating almost entirely in the States. Very little of the American coal, however, is bought by other consumers than the Navy. The Oriental coal trade with the Philippines has so far been monopolized by two producers separated by a sailing distance of over 3,500 miles. These two, Japan and Australia, are the principal sources of coal mined on both borders of the great Pacific, and together control half the coal output of that drainage area. In coal-mining around the Pacific the only other regions worthy of note are, in appproximate order, Washington, New Zealand, British Columbia, North China, Mexico, and Chili. Their production ranges in round numbers from one million tons in Chili to three million tons in Washington, or in no case as much as one-third the production of Japan.

Australia, or rather New South Wales, to be more specific, has lately taken the leadership from Japan in supplying the coal market of the Philippines. While the War Department (the principal Philippine customer of the island empire, and the contractor here for Japanese coal only) has suffered a decrease in its requirements since the inaugural of civil Government, the latter and the private consumers, on the other hand, both favoring Australian coal, have experienced a rapid growth in their demands during that time.

The success of the Australian product in the Philippine market may be ascribed to its superior quality compared with the Japanese coal, combined with a gradual reduction in the price asked for the former. The Australian fuel, as delivered in Manila, is entirely bituminous coal of Permo-Carboniferous age, and its fixed carbon alone, on the average from 25 to 45 per cent above that in the Japanese coal, has a heating capacity generally exceeding 6,000 calories.* The coals from Japan are mostly bituminous, slightly lower in ash, and about equal in total heat units to the Australian fuel, but much richer than the latter in gaseous hydrocarbons. They are inclined to be lignitic and rather unclean, and are furthermore much younger, never found in beds of earlier age than the Mesozoic, but usually intercalated

* The fixed carbon, i. e., carbon in the coke, must here be made the real basis of comparison between these coals, since the exports of both Japan and Australia are utilized almost entirely on steamers whose boilers, as a rule, are not adapted for obtaining the best results from fuels which, like the Japanese and Philippine, are relatively rich in volatile combustibles.



TAKASHIMA COLLIERY, EIGHT MILES FROM NAGASAKI, JAPAN.
One of the sources of Philippine coal supply. On this island of Taka, coal has been extracted from under the sea at a depth of 900 ft. Two shafts were being sunk within this coffer dam, outside the shore line, when the picture was taken. Mr. Tsumaki, chief mining engineer, is standing in the center.

between Tertiary strata. The typical Japanese coals of commerce differ chiefly in the amount of moisture present from the better grades of Philippine black lignites of similar age, which here and there actually grade into true bituminous coal. In the former the water content is generally less than 5 per cent, but in the latter it occasionally runs as high as 20 per cent.

To compensate for this decided advantage in the quality of their coal, the Australian producers have been severely handicapped by greater costs of mining as well as higher rates of transportation. Although the colliery operators of New South Wales have materially reduced the cost of coal* at the pit mouth during the past twenty

* A few years ago the average cost of producing coal per long ton was $1.22 in Japan compared with $1.40 in New South Wales. At the same time it was only $1.15 in the United States where coal-mining machinery is so extensively employed. During the fifteen years ended in 1898, the mine managers in New South Wales had succeeded in cutting down the expense of placing their coal at the pit mouth from $2.31 to $1.33. More recently that cost has risen, from $1.48 in 1900 ($1.01 in the United States) to $1.80 in 1902 ($1.09 in the United States). See "Commercial Japan in 1904" and "The World's Coal Supply and Trade," monographs of the Bureau of Statistics, Hon. Oscar P. Austin, chief; also "Mineral Resources of the United States," 1903, and "A Statistical Account of Australia and New Zealand," 1902-1903, by T. A. Coghlan.

TYPICAL VIEW OF FOREST AND JUNGLE, BATAN ISLAND.
Taken near the Bilbao Mines, east of the reservation. Japanese are working on the trail.

years, the Japanese mining companies can still produce the fuel at an outlay considerably less, owing above all to the lower wages paid in the "Land of the Rising Sun."

While distance is not the only element determining transportation charges, it is, nevertheless, the principal one in this particular case of competition between Japan and Australia. The great port in the coal trade of Australia, namely Newcastle in New South Wales, is removed, by the shorter water route, about three times as far from Manila* as are Moji and Nagasaki, the principal ports of Japan in its coal trade with the Philippines. This geographical advantage of Japan is altogether of far greater significance than the economic one of production, especially when it is considered that a very large part of the purchases of Japanese coal made by the War Department of the United States is delivered directly to transports calling conveniently at Nagasaki *en route* to or from the Philippines.

* Fully nine-tenths of all the coal that is brought to the Philippines is delivered at Manila, Marivales, and Cavite, the two last named being well-known coaling stations on Manila Bay.

Thus it is that in discussing the prospects of the United States Federal Government* supplying itself from native sources with the mineral fuel needed in the Philippines, an absorbing question of dollars and cents will arise. Can the Government mine Philippine coal (i. e., coal equivalent to the average fuel furnished by Japan) and deliver the same at suitable coaling centers at a cost at least as low as the Philippine prices of Japanese coal?

TABLE SHOWING PRICES OF COAL PURCHASED BY THE U. S. WAR DEPARTMENT ON ACCOUNT OF THE PHILIPPINES.†

Year.	Source.	Description.	Tonnage.	Price.	Place of delivery.
1901	Japan	All delivered at Manila.	87,361	$7.78 a	Manila.
1901	do.	do. do. Nagasaki	142,900	3.26 a	Nagasaki.
1901	do.	Komatsu (Kyushu I.)..	62,185	3.19 s	do.
1901	do.	Yoshinotani do. ..	40,544	3.33 s	do.
1902	do.	All delivered at Nagasaki	49,831	3.66 a	do.
1902	do.	Miiki (Kyushu Island).	24,476	3.30 s	do.
1902	do.	do. do. do. .	60,482	5.65 s	Manila.
1902	Australia	Duckinfeld (N. S. W.)	3,682	9.00 s	do.
1902	Japan	Tagawa (Kyushu Island)	9,125	7.00 s	Iloilo and Manila.
1902	do.	Mutabe do. do.	21,022	4.00 s	Nagasaki.
1903	do.	do. do. do.	31,364	4.00 s	do.
1903	do.	Kishima do. do.	50,230	5.38 s	Manila.
1903	do.	Yoshinotani do.	30,199	5.23 s	do.
1903	do.	do. do. do.	6,634	6.75 s	Zamboanga.
1903	do.	All del'd at Nagasaki...	49,210	4.00 a	Nagasaki.
1901-3	do.	do. do. do. do. (3 yrs.)	241,941	3.49 a	do.
1903	do.	Miiki (Kyushu Island).	12,123	3.70 s	do.
1905	do.	do. do. do. .	?	3.00 s	do.
1904	do.	?	?	4.80 s	Manila.
1901-3	do.	All Philippine deliveries.	244,031	6.38 a	Philippines.

The above table shows that the prices of Japanese coal delivered at Manila to the War Department from 1901 to 1904 fell but once below $5.00, and that the average of that delivered from 1901 to 1903 exceeded $6.00. For the immediate purpose of this article the minimum Manila price to the military branch of the United States Government will be taken, in round numbers, at $5.00, an amount much less than the open-market price of Japanese coal, which, in turn, is generally one dollar lower than that of the Australian product.

Let it be assumed, in the present discussion, that coal can be mined in quantity in the Philippines at a cost of $2.00‡ per ton which is fully 25 per cent above the average cost of Japanese coal at the pit mouth, a very liberal allowance. Let $1.00, a very reasonable esti-

* That is, the Army; since the Navy, the only other direct representative of the Federal Government, upholds too high a standard for the use of Philippine coal.

† The data here given are all for fiscal years ended June 30. The quantities indicated are in long tons and the prices in United States currency, "a" being average price and "s" specific or contract price. The entire table has been compiled from information furnished by the Quartermaster's Department, U. S. A., Manila.

‡ The average cost of mining bituminous coal in the United States is usually not much more than $1.00 per ton.

mate, be allowed for the expense of placing it on board Army transports or other vessels, including thereunder the cost of a short railway haul. That would make a maximum total of $3.00, the same as the contract price in 1905 for Japanese coal f. o. b. transports or colliers at Nagasaki, and about $2.00 below the minimum price paid by the Army for the latter at Manila. As the deliveries at Manila have approached the hundred thousand mark in recent years, the total saving which might be annually effected by the War Department alone, through the insular production of all this coal, would approximate not less than $200,000; surely no mean amount!

While the prospect of losing annual sales of a hundred thousand tons (or even a little more if the Nagasaki deliveries be also cut off) may be disheartening to certain Japanese coal dealers, particularly the Mitsui Bussan Kaisha, such a loss would really signify but little in Japan's entire export trade in mineral fuel. In 1902 only 4.4 per cent of the foreign-bound coal shipments* went to the Philippines compared with 1.9 per cent to the Dutch East Indies, 14 per cent to the Straits Settlements (mainly to Singapore), 31 per cent to Hongkong, and more than 44 per cent to China. If such possible decrease should be limited to Manila deliveries to the Army, the per cent loss to Japan's total export trade would be less than 1.0 instead of 4.4.

Doubtlessly it was the fear of colliers from foreign countries being intercepted in time of war—thus a matter of necessity rather than of mere economy—that led the late Secretary of War, Mr. Root, to instigate inquiries concerning the possibility and practicability of supplying Philippine coaling stations with serviceable fuel taken from mines within the archipelago.

The pioneer, indirectly, in this work of investigation for the American government, was Dr. George F. Becker† of the United States Geological Survey. He served as geologist for the Military Government in 1898, and in connection with his general geological studies personally visited a few coal prospects on Cebu and Negros, but owing to the disturbances and attendant dangers at the time, he could not make extensive observations.

Hon. Chas. H. Burritt, now a judge of the Court of First Instance in the Philippines, compiled a valuable report in 1901 when he was

* In 1902 Japan sold to foreign countries 30% of her coal output, while England, whose coal exports exceed those of the rest of the world collectively, sold only 20% of her home product. In the same year New South Wales disposed of 55% of her yield to other colonies and foreign countries.

† One of the earliest reviews of his valuable study of the Philippines appeared in THE ENGINEERING MAGAZINE. His "Geology of the Philippines" contains eight pages on the coal resources.

the army officer in charge of the Mining Bureau at Manila. In his history of coal discoveries and efforts at mining under the Spanish *régime*,* Judge Burritt accounts for the delayed development of the coal resources largely on the grounds that the Government was actually antagonistic thereto. To his explanation must be added: unsystematic and insufficient explorations, poor financing, bad management, and scarcity of skilled labor. He enumerates three causes that "influenced the officers and employees of the Spanish government in their manifest opposition to the use of Philippine coals":—1. The prices paid for English coal used by the Spanish navy were so extravagant as to easily allow for the percolation of a large per cent into the pockets of the Spanish officials. 2. The custom of buying coal from England was well established and was very convenient to the Spanish purchasing agents and others who disliked change. 3. The engineers and chief machinists of the Spanish navy were largely Britons who regularly reported unfavorably on the use of other than British fuel.

Direct investigations, with the view of ultimately opening and operating Government coal mines, were inaugurated in 1901. That was just after the appearance of Judge Burritt's encouraging report, when the commanding general of the Philippines was advised that such was the desire of the Secretary of War. First-Lieutenant Edward M. Markham, corps of engineers, was appointed in September, 1901, to make a preliminary and general survey of the more promising localities where coal had been found. This officer submitted, late in March, 1902, a comprehensive report wherein the coal deposits on Batan island were recommended for future and more minute examination, in preference to the two other favorable occurrences observed, one in the province of Zamboanga in western Mindanao and one in Cebu, the province embracing the island of the same name.

The reasons advanced in favor of this small island, no larger than an ordinary American township, were threefold. 1. *High calorific power of merchantable coal.* The analysis of the seam supplying what was deemed the most marketable coal on Batan island indicated a higher fuel value than that of any coal seam examined elsewhere, although one sample from Zamboanga had a slightly greater percentage of fixed carbon. 2. *Ideal harbor near the outcrop of coal.* A deep-sea anchorage, well protected, approaches within half a mile of the nearest outcrop of the bed referred to, thus involving a minimum outlay for land transportation. 3. *Location near route of army trans-*

* "The Coal Measures of the Philippines," Bureau of Insular Affairs. Pages 11-12 and 174-177 of this report deal with coal-mining on Batan Island.

ports. The position of Batan island* is not only quite central with respect to the Philippines as a whole, but is far superior to that of any other spot similarly adapted for a coaling station, inasmuch as the island is situated scarcely forty miles, or three hours of ordinary steaming, north-north-west from the course which army transports take in going from San Francisco to Manila via the neighboring strait of San Bernardino.

As a result of Lieutenant Markham's recommendations, the western three-fifths of the island was withdrawn from entry and made a temporary military reservation on July 1, 1902. A fund of $15,000† was made available February, 1903, for the exploitation of a limited portion of this area. Finally, in June, 1903, First-Lieutenant Hubert L. Wigmore, then on the staff of General Davis, was detailed in charge of the development work. This officer had previously distinguished himself through bravery in the Moro campaign. His map of Jolo was the first reliable one of that island to appear.

Lieutenant Wigmore arrived on Batan island early in July, 1903, bringing with him, besides a detachment of American soldiers, a force of about twenty-five Japanese, mostly miners. The introduction of this foreign labor was absolutely unavoidable. The climate, not to mention the high cost, militated against the employment of white labor; immigration laws forbade the entry of Chinese; while superstition and lack of skill were the obstacles in the way of working the native Filipinos underground. In justice to the natives, both Tagalogs brought down from Manila, and Bicols living in the vicinity, it must be said that, considering all their conditions of life, they gave good satisfaction as unskilled surface workmen or even as timbermen and carpenters. It was rather remarkable how many of them actually reported for work on some *ficsta* days. Altogether up to fifty Filipinos were carried on the pay-rolls at times, which, with the Japanese enlisted men, and the few civilians, made the total number of persons employed at the Government Coal Mines seldom as many as one hundred.

Mr. Wigmore, as the executive head of the enterprise, was exceedingly energetic, very conscientious, and quite capable for his task. He personally supervised all the construction work. That included the

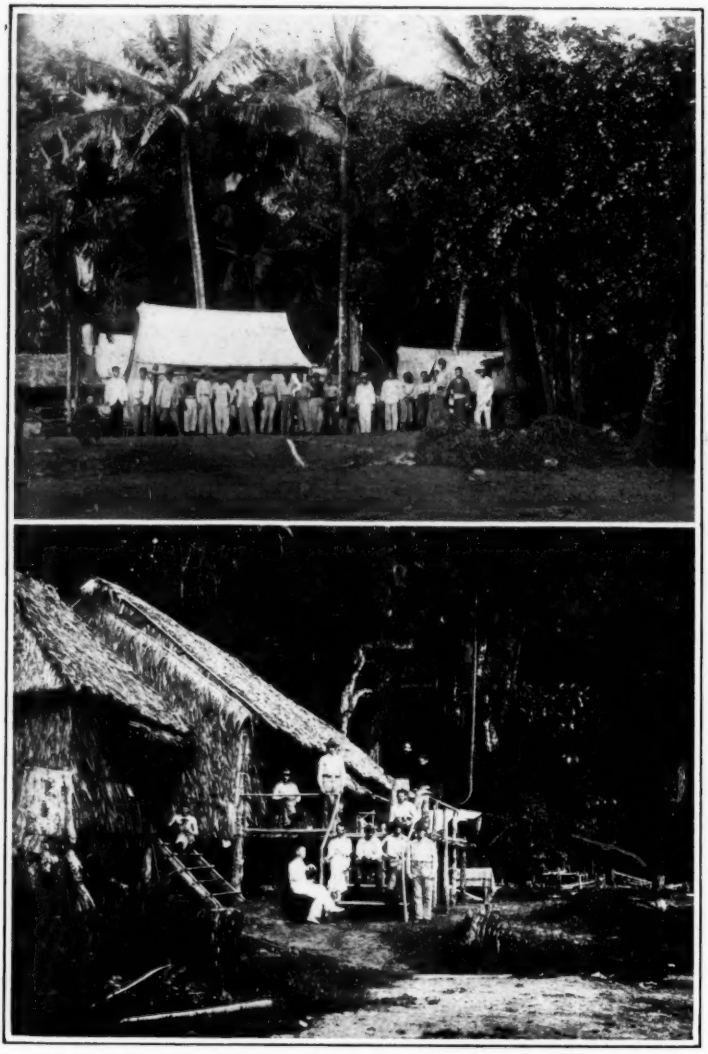
* The dock built on Coal Harbor, near the western extremity of the island, lies in latitude 13° 16′ 0″ north and in longitude 123° 54′ 07″ east of Greenwich. From Manila, Batan is distant about 400 miles by route of steamers, and in an airline only 230 miles S. 65° E. It is 570 miles from the northernmost islands of the archipelago, 650 miles from the southernmost members, and only 80 miles east of the center of the boundaries of the Philippines delineated by the treaty with Spain in 1899.

† Subsequent allotments increased this successively to $32,000 and $90,000.

MESS TENT OF LIEUTENANT WIGMORE AND MR. REINHOLT, SEPT.-DEC., 1903.

building of a small stone dock, and, under great difficulties, the building of a narrow-gauge incline one-fourth mile long; the erection of an office and ware-house on the dock, and of permanent quarters elsewhere for the officials and employees; also the impounding of potable water for use during the dry season. The mining of large lots of coal for experimental purposes and local use of the government was entrusted largely to competent Japanese foremen, the miners working first on a wage basis and later on contract. Most of the topographic surveys of the reservation as well as the soundings in the harbor were executed by members of the corps of engineers, directed by Lieutenant Wigmore.

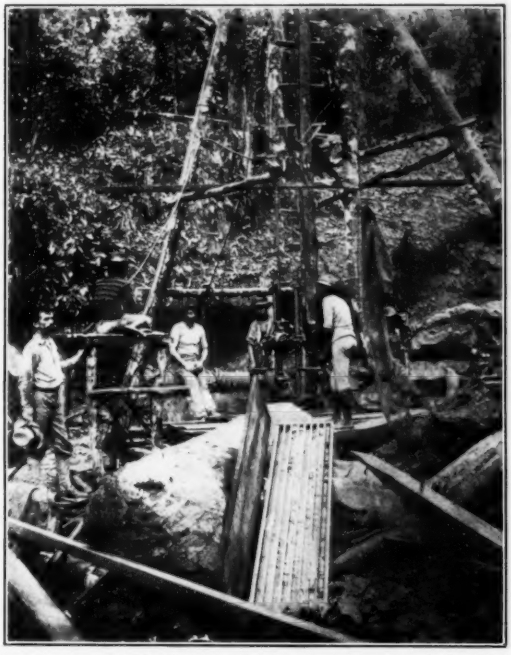
I landed on the island two months later than the commanding officer. My duties as superintendent of exploration comprised the making of reconnaissance surveys, both geologic and topographic, and the sampling and analysis of the fuel deposits. But it was more particularly the supervision of the diamond drilling that engaged my attention and for which my services as a mining engineer were loaned by the civil government to the military authorities. That work of drilling, representing the *first scientific* or *systematic prospecting con-*



RESIDENCE QUARTERS, GOVERNMENT COAL MINES, BATAN ISLAND.

The upper view shows the quarters of non-resident native employees; the lower, the barracks for the enlisted men.

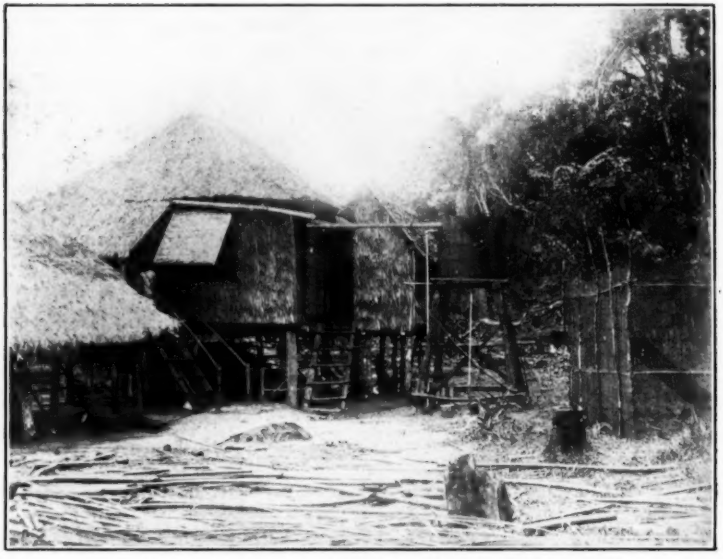
ducted in the Philippines, was begun in September, 1903, and carried on, with minor interruptions, until May, 1905.



THE FIRST PROSPECT HOLE IN THE PHILIPPINES BORED WITH A DIAMOND DRILL. GOVERNMENT COAL MINES, BATAN ISLAND, OCT., 1903.

The Bravo machine (Sullivan Machinery Co.) was used. Diameter of hole, 1 9/16; of core, 15/16; total depth, 101 ft., the lower 14 ft. being in fissured or cavernous limestone. A single bit, set with carbons by the superintendent, did the work.

Additional drills and an expert drill foreman from the States reached the Government Coal Mines in July, 1904. By the more extensive drilling for which these provided, as well as the more intensive operations permitted by means of continuous eight-hour shifts, a very large amount of exploring was done in the ensuing ten months. The foreman, whose name was Gustav Carlson, and who had served with me in a similar capacity back in the States, assumed charge of the actual drilling upon my departure. A great deal of credit is due this man for accomplishing so much as he did in spite of discouraging conditions familiar to all engineers who have lived and struggled any length of time in the tropics. Altogether, nearly 6,000 feet of shallow drill holes were bored at twenty-three separate points within an area of less than a square mile on the reservation near Coal Harbor. Gasoline engines were utilized for much of the motive power; nevertheless it was the hand-power of natives running the "Bravo" machine that bored the deepest hole, yielding cores 1⅜ inches in diameter to a vertical depth of 350 feet below the surface.



TEMPORARY QUARTERS OF OFFICIALS, JANUARY-MARCH, 1904.
The hut is built largely of bamboo and thatched with *nipa* palm leaves. The elevation on posts, to permit air circulation between the floor and the damp ground, is characteristic of the native huts.

Batan island, which has been the scene of all the above activity, is the largest of a chain of four islands jutting out into the Pacific on the north side of Albay gulf, southeastern Luzon. It has an extreme width of nearly five miles and a length of about fourteen miles. Like its neighbors, it is quite mountainous, the limestone peaks in some parts rising 1,000 feet and more above sea-level. Its outline is rather irregular, two large bays indenting the north shore and two minor ones the south shore. The island is surrounded on all sides with fringing coral reefs, a menace to navigation in some places.

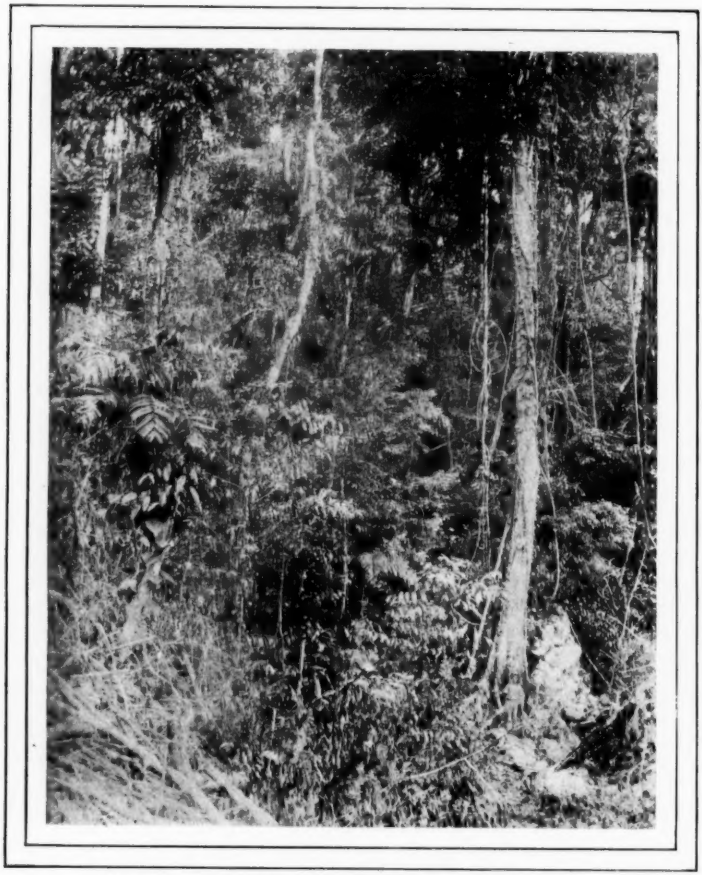
The climate of this locality is warm, wet, and oceanic, like the prevailing climate of the Philippines. The temperature is remarkably uniform; the daily extremes noted in several months while I was volunteer observer for the Philippine Weather Bureau, were 74 degrees F. at 6 a. m. and 91 degrees at 3 p. m. The heat, however, is more oppressive than these figures would imply, since the atmosphere throughout the year is so highly saturated. The rainfall, accurately registered for fifteen months, does not differ essentially from that of Legaspi, the hemp port which is situated sixteen miles to the

west and which ranks among the more humid stations in the archipelago. Over 100 inches of rain have fallen there in single years. Fortunately for engineering undertakings, such as mine pumping, the precipitation here during normal years is more evenly distributed than in many other places in the islands, and yet some days and even months have witnessed a phenomenal downpour. For instance, once during April, 1904, over 7 inches came down in 24 hours, and during the whole month of December, 1903, when there were only three clear days but much typhoon weather, a rain-fall of more than 35 inches was recorded.

In consequence of the climatic relations the plant life is extensive, dense, and varied. Fully three-fourths of the area is wooded, or proportionately a little more than the average throughout the archipelago. The only noteworthy barren ground covers hills of serpentine, soil from which is anywhere unfavorable. There are present on the island many of the 900 species of Philippine hardwoods, most of which are heavy and a few quite large. Some of the trees are the equivalent of Central American mahoganies, but only a few of them are well adapted for mine timbers. Besides trees may be seen bamboo, tree-ferns, lianas, palms, and other tropical plants, including beautiful orchids. Monkeys, deer, wild hogs, a few snakes, enormous tree-bats, a large species of lizard, and some peculiar birds, such as the red-billed *calao* which emits a horrible cry, are the larger denizens of the deep forests. Scorpions and centipedes abound as the arthropods of unpleasant reputation. Among insects, the white ants, notorious

Photo by Deberri.

A SPANISH BUNGALOW, HEADQUARTERS OF THE COMMANDING OFFICER AND SUPERINTENDENT OF EXPLORATIONS, BATAN ISLAND.



FOREST ALONG THE GOVERNMENT RAILWAY, BATAN ISLAND.

The air plants and lianas are here particularly prominent. A Japanese, standing at the foot of the largest tree, gives an approximate idea of its height.

as wood-destroyers, are worthy of mention as having once caused a wreck on the trestle of the railway. It is an interesting fact that mosquitos are not annoying on Batan island, but the leeches make their mark instead, especially when the vegetation is damp. The human inhabitants, belonging to the tribe of Bicols, number over 2,000, and are concentrated in villages along the coast. They are engaged principally in fishing and in the production of *abacá* or Manila hemp. As a matter of curiosity, I have observed in the interior a couple of specimens of

the Aetas or Negritos, remnants of the pygmy autochthones of the Philippines.

About one-eighth of the area of Batan island is of volcanic origin. Nearly all of this part consists of a continuous ridge of serpentine, rising 600 feet above sea-level and extending along the north shore five miles from the northeastern point of the island. Apparently the same altered rock is exposed in two limited spots on the south shore, separated from each other over four miles.

With these exceptions the surface formations of the island appear to be entirely sedimentary. The stratified rocks, embracing an upper and a lower limestone with the coal measures interbedded, seem to lie unconformably against the basic eruptive above referred to. The upper limestone appears to be at least 700-feet thick, and the coal measures fully 300 feet. Wherever limestones occur there the Karst phenomenon of roofless caves has been extensively developed. Large and beautiful terraces of tufa have been built near the base of the limestone elevations. Faults and folds are not uncommon, but their extent has not yet been fully determined. The strata are horizontal

THE EFFECTS OF TROPICAL RAINFALL. LANDSLIDE AT THE URGERA ANTICLINE.

HAULING COAL ON SLEDS FROM THE SAN FRANCISCO MINE TO THE HEAD OF THE URGERA RAILWAY.
By means of greased runners and slats across the trail, the Japanese workmen guided sled loads of 1,200 lb. down grade half a mile. The view is taken in a grove of cocoa-palms and hemp palms, the latter belonging to the banana family.

in only a few places and dip elsewhere as high as 58 degrees.*

The sedimentary series belongs unquestionably to the Tertiary period. Professor Mayer of Zürich, Switzerland and Doctor Dall of our Smithsonian Institution, agree, from the examination of fossils collected and personally submitted by me, that the upper limestone should be referred to the Oligocene epoch.† Doctor Dall concludes that the coal is probably Eocene. As regards the age of the igneous rocks, the most that may be said with certainty is that they date from pre-Tertiary times.

The coal measures are made up of alternating beds of shales, sandstones, clays, and black lignite or lignito-bituminous coal, besides a few small bands of limestone in their lower horizon. As many as five different beds of fuel have been distinguished. These measures increase in thickness, but apparently grow more and more barren of coal towards the north shore, where along Gaba bay, the sandstones and shales of the upper portion of the measures may be regarded as trachyte tuffs slowly deposited in water. A little southwest of Calanaga bay, the eastern one of the two major indentations on the north

* Faulting is no doubt still in progress, as evidenced by the frequent earthquakes in this vicinity. Between Dec. 6, 1903, and May 3, 1904, the writer experienced eight distant shocks, four distinct ones occurring on April 27.

† "The presence of Ampullinopsis among the shells is indicative of this age."—Letter from Dr. Wm. H. Dall.

shore, a Spanish company has operated within the past ten years, first mining coal by means of expensive Spanish labor and later (1903-4) with the help of Japanese. Here the maximum thickness of coal seams examined is about five feet; but near the south shore, towards the western end of the island, twenty feet of coal was penetrated by a drill; and at the apex of the anticline on the Urgera *pertenencia** there is an abnormal accumulation of over 30 feet of mineral fuel. However, the greatest *normal* thickness of any seam on the island, measured at the surface by me, did not exceed 8 feet.

Of the just stated thickness at the outcrop was the "Big Tree" seam from which a sample lot of 10 tons gave highly satisfactory results when thoroughly tested on board the U. S. Army Transport "Wright" late in April, 1904. Compared with the "Kishima" coal from Japan, tried almost simultaneously under identical conditions, the Batan coal was found to contain 25 per cent more lump, to produce the same speed of 13.3 knots per ton per hour, to yield less dark smoke, and to leave no clinkers instead of many, and only 9.8 per cent of dry refuse instead of 19 per cent. There was also less work involved in firing with the Batan fuel, owing to its superior cleanliness, low ash content, and little waste.

Determinations made by me on a number of samples taken within 50 feet of the outcrop of this particular bed showed an average specific gravity of

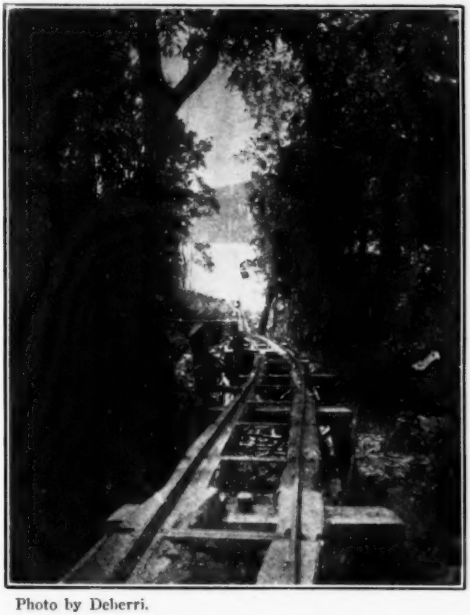
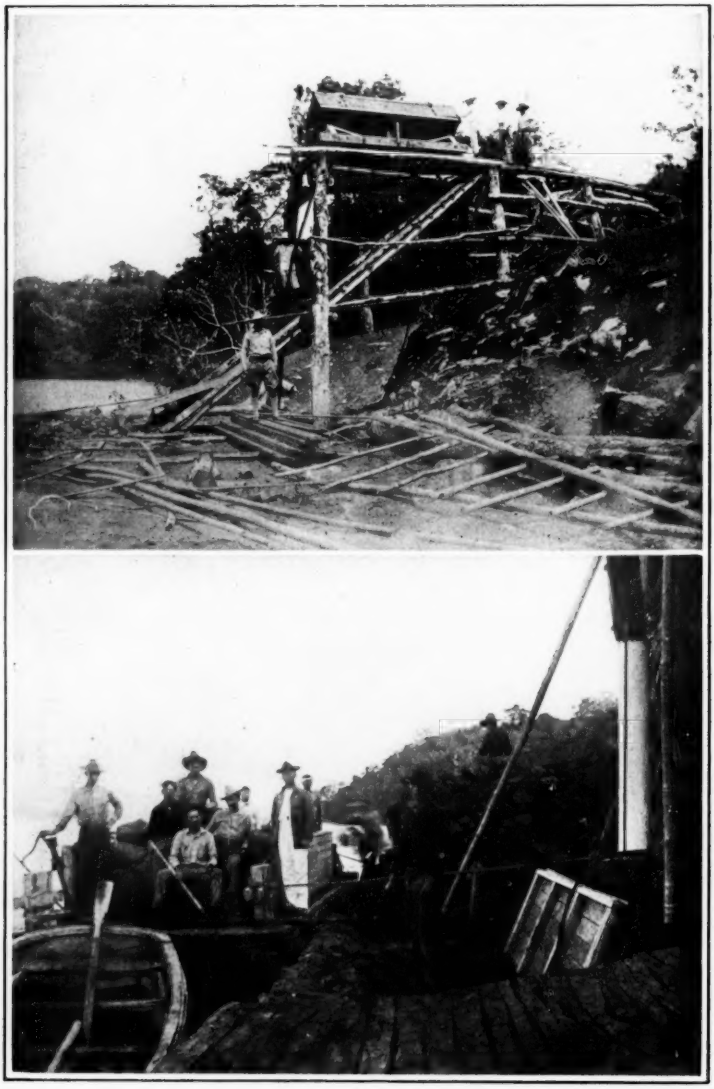


Photo by Deberri.

THE COMPLETED RAILWAY, LOOKING DOWN A HEAVY GRADE TO THE COAL HARBOR.

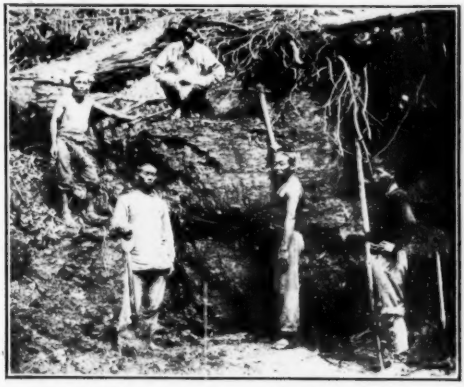
* One of the private claims within the reservation, tunnelled into a short distance many years ago.



BRINGING THE COAL TO TIDE-WATER.

The upper view shows a provisional tipple at the dock; the lower, a corner of the stone dock itself, with a coal-laden lighter.

1.35 in the natural state. The hardness and the crushing strength of the Batan coal was sufficient for it to be practically unaffected by more or less rough usage incidental to its being twice dumped down long slides in the course of transportation. A limited number of experiments demonstrated that the coal possessed coking qualities.

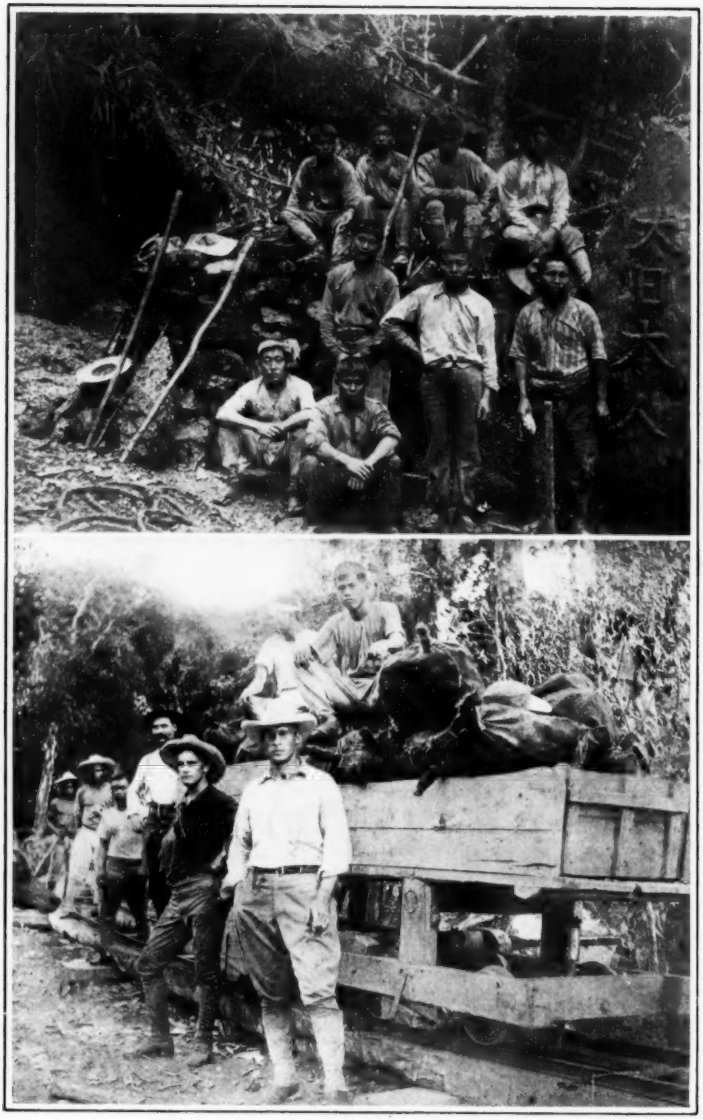


BIG TREE SEAM ON THE SAN FRANCISCO PERTINENCIA.
A bed of 7.7 ft. of excellent lignito-bituminous coal, with a northerly dip of 11 degrees. Both floor and roof are shales.

Chemical analyses would indicate that the fuel is a low-grade bituminous or lignito-bituminous coal, like the best soft coal of the Yampa field in Colorado, rather than a mere lignite. The volatile combustibles approached 40 per cent, while the fixed carbon in several cases exceeded 50 per cent. The ash content varied from 4 to 7 per cent, and the moisture a little higher, but generally less than 10 per cent. There was present, mainly in the form of marcasite, less than 1 per cent of sulphur, or not enough of this undesirable element to prevent the fuel being used even for smelting purposes if it were otherwise suitable.

On the whole, the results achieved in exploring the Batan coal field were not at all disappointing, though probable difficulties for future mining were revealed. The quality of the fuel proved satisfactory, and likewise the quantity underlying the area examined with

JAPANESE OFFICIALS AND EMPLOYEES, BILBAO MINE.
The Japanese mining engineer, Mr. Gato, is leaning on his cane above the tunnel. Below are coolies, in characteristic poses, carrying out coal in baskets. Tram cars were introduced later.



THE FIRST CAR OF COAL LOWERED TO THE RAILWAY TERMINAL, AND THE MINERS.
Lieutenant Wigmore is in the foreground of the lower picture. The Japanese miners are shown grouped above. Just before the picture was taken, March, 1904, they had heard of a victory won by their countrymen 2,000 miles away, and had commemorated the occasion by decorating the large piece of coal on the right with the clay letters *Dai Niphon*—"Great Japan."

COAL FROM THE BIG TREE SEAM ON THE DOCK, WAITING TRANSFER TO THE BRIGANTINE LYING IN THE HARBOR.

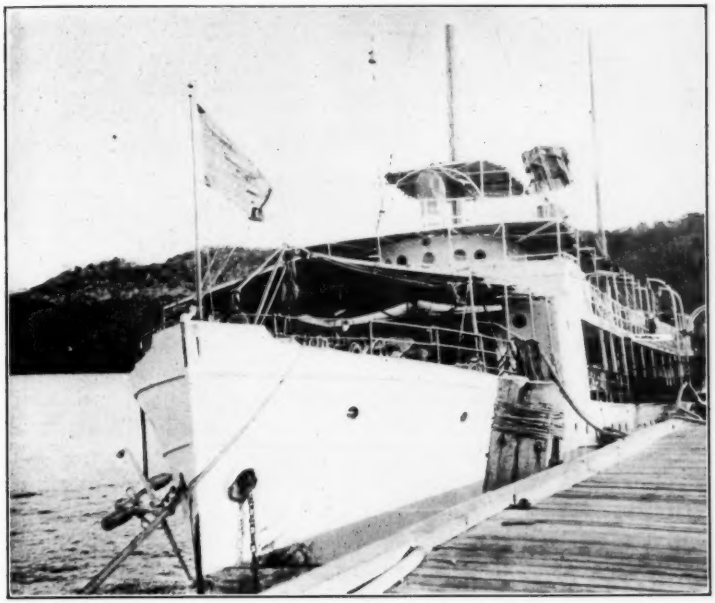
The large masses, intact after rough handling in transit from the mine a mile away, prove the fine physical quality of the coal.

drills. Meanwhile, until the authorities act upon Lieutenant Wigmore's recommendation to work these deposits on Batan island, other promising fields in the Philippines will be given attention under the auspices of the Manila Mining Bureau, of which Mr. Hiram D. McCaskey is the chief.

The Government is justly encouraged in believing that an abundant supply of really serviceable steaming coal exists in these islands. It has direct access to the latest facts concerning the Philippine coal measures, not yet made available to the public, and has gained already much experience of a practical nature essential in developing these deposits. It has at its disposal wider opportunities and greater power and perseverance than can be looked for among any individuals or groups of individuals who might become interested in exploiting this most valuable mineral asset of the archipelago. As already pointed out, the Government, be it the military or the civil division of the same, need not become alarmed at the possibility of injuring private interests, for there are none of these established in coal-mining in the islands on anything like a productive basis.

ADIT TO ONE OF THE COAL BEDS LOCATED BY DRILLING.

Should the Government then, if it wishes to mine coal in the Philippines, hesitate to help itself and by its example help others? Hardly so, I think, in these days of national operation of coal mines abroad and of public clamoring for Government ownership of various monopolies in the United States. It will be noted that this is a contention for the creation of a Government industry, not for the



THE TRANSPORT "WRIGHT" AT QUARANTINE DOCK, MARIVALES, MANILA BAY.
Comparative tests of Japanese and Batan coal were made on this vessel in April, 1904.

purpose of filling private wants, but for the partial supplying of a single need of the Federal Government by drawing upon one of the latent resources of a distant possession.

The Government has authority to reserve unlimited areas of unoccupied lands for purposes of coal-mining on its own account, something which it has once availed itself of as recorded in the past pages. There is a limit, however, on the amount of coal land which private persons may acquire. The following is abstracted from the new Coal Land Law enacted April 28, 1904, but based upon the earlier one of July 1, 1902:

A properly qualified individual, such as a citizen of the United States, may purchase 64 hectares (158 acres), and an association of such persons, 128 hectares (316 acres), but no more, of "unappropriated public land which is chiefly valuable for coal." If no adverse claim be made during the required nine consecutive weeks' publication of the notice of application "the applicant is entitled to a patent upon payment * * * * * of 50 pesos ($25 U. S. currency) per hectare ($10.12 per acre) where the land shall be situated more than fifteen miles from any completed railroad, available harbor, or navigable stream, and 100 pesos ($50 U. S. currency) per hectare ($20.23 per acre) for such lands as shall be within fifteen miles of such road, harbor, or stream."

A REVIEW OF CONDITIONS IN THE AMERICAN IRON INDUSTRY.

By Edwin C. Eckel.

Mr. Eckel's review brings out with admirable clearness the most interesting features of one of the most interesting years in the history of the American steel industry. Not the least significant of the points he makes is that concerning the comparative ore reserves of the Lake Superior district and of the Southern States. It is possible that the facts of this matter, which have not heretofore appeared in print, have been rather overlooked by the Northern iron and steel magnates in their consolidation plans and arrangements.—THE EDITORS.

IN the course of a recent article* dealing with the various mineral products of the United States, the iron ores and iron industry were described, of necessity very briefly, attention being called merely to their great industrial importance and to their relative rank as compared with the precious metals. The present article contains a somewhat more detailed discussion of the American iron industry, including under that head both the raw materials and the finished products of iron manufacture. The subject can be most naturally handled by describing first the iron ores of the United States, then the production of iron and steel, and finally the position held by the country, as compared with other nations, in the iron industry as a whole.

It is proper to state here that the data on pig-iron and steel production used in this article are those collected by the American Iron and Steel Association; and that the results for 1905 are presented by the writer through the courtesy of Mr. J. M. Swank, Secretary of that organization.

I. The Iron Ores of the United States.—The commanding position which the United States has attained in the iron industry has been largely due, of course, to its supplies of raw materials and to the enormous demand caused by the development of the country, and directed exclusively to home producers by the operation of the protective tariff; for other countries have been able to secure cheaper labor and equally extensive markets. The transportation systems, too, have aided greatly in the development of the American iron industry, making it possible for Pennsylvania and New York furnaces to draw their ore supplies from Minnesota, and still make iron at a profit.

* "The Mineral Industries of the United States," THE ENGINEERING MAGAZINE, November, 1905.

The distribution of developed iron ores throughout the country is well shown in the following table, in which the production of the various States for 1903 and 1904 is given separately. It will be seen that Minnesota is by far the most important producer, turning out annually over 40 per cent of the total. Michigan follows, producing about one-fourth of the whole output, and Alabama is third with about one-eighth. The other States are of much less importance.

	1903.	1904.		1903.	1904.
Minnesota	15,371,396	12,728,835	Mont., Nev., N. M., Tex., Utah, Wyo..	426,292	210,945
Michigan	10,600,330	7,089,887	Colorado	252,909	150,972
Alabama	3,684,960	3,669,881	North Carolina	75,252	64,347
New York....	540,460	842,303	Missouri	63,380	49,285
Va. and W. Va.	801,161	550,253	Kentucky	32,227	35,000
Tennessee	852,704	500,982	Conn. & Mass.	30,729	21,990
New Jersey....	484,796	499,949	Ohio	29,688	15,672
Wisconsin	675,053	483,475	Maryland	9,920	9,645
Pennsylvania .	644,599	397,107			
Georgia	443,452	293,802	Total U. S..	35,019,308	27,644,330

The statistics of production given above for the separate States are rendered much more intelligible and useful when the States are combined in their natural commercial groups, as has been done in the table following:

	Tons.	Per cent.	Tons.	Per cent.
	1903.		1904.	
Lake Superior District.....	26,646,779	76.1	20,302,197	73.4
Southern United States.....	5,997,106	17.1	5,223,195	18.9
Central and Eastern United States.	1,730,272	4.9	1,777,021	6.4
Rocky Mountain States.....	645,151	1.9	341,917	1.3
	35,019,308	100.0	27,644,330	100.0

During these years, therefore, the Lake Superior district furnished about three-fourths of the total supply of iron ores. Detailed figures for 1905 are, unfortunately, not yet available; but it seems probable that they will show not only a greatly increased tonnage over either 1903 or 1904, but a relative increase in the output of the Lake Superior district. During the shipping season of 1905, up to Nov. 3, the amount of ore shipped from Lake Superior ports was 29,730,615 tons, as compared with 17,657,159 tons shipped during the corresponding portion of 1903. This would indicate a total production in the Lake Superior district of over 33,000,000 tons. The southern mines did not expand their output, in response to the increased demand for ore, as rapidly as did the Lake mines, and I think it safe to say that during 1905 the Lake district probably produced almost 80 per cent of the total iron-ore output. Allowing, as above noted, 33,000,000 tons

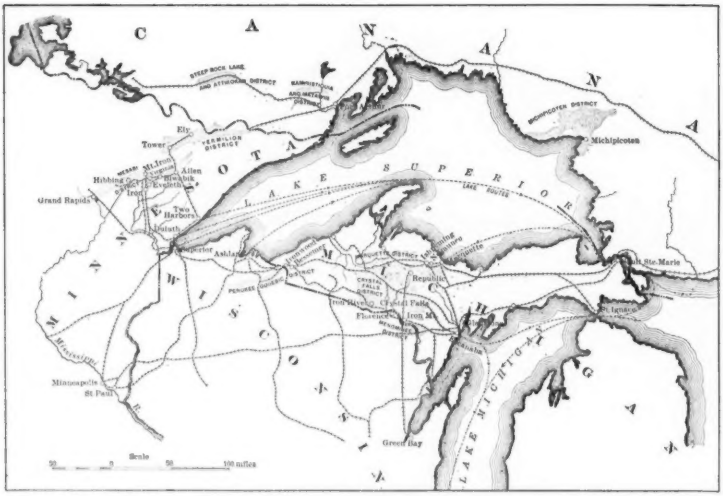


FIG. 1. SKETCH MAP OF LAKE SUPERIOR IRON REGION, SHOWING ORE DEPOSITS, SHIPPING PORTS, AND TRANSPORTATION LINES.

as the probable total of Lake ore mined during 1905, the total for the entire United States can hardly fall below 45,000,000 tons.

The enormous iron-ore deposits which are included in the Lake Superior district occur, as shown in Figure 1, in the States of Minnesota, Michigan and Wisconsin. Closely allied deposits occur across the border in Canada, but these need only be alluded to in the present connection.

The Lake Superior ores are mostly hematites, with much smaller proportions of magnetite. The Mesabi range, the most recently opened of the great ranges, produces a fine-grained ore which can be excavated readily by steam shovel. Objections by furnacemen to the use of this fine ore are gradually passing away, and the Mesabi is now the most important of the Lake ranges.

A few charcoal furnaces are running near these deposits, but by far the greater part of the Lake ore is shipped east to Chicago, Cleveland, Pittsburg, Buffalo, etc. Most of the ores are of bessemer grade, and carry in the neighborhood of 60 per cent of metallic iron. During the early part of 1905 Lake ores from the Mesabi range were delivered at Lake Erie ports for $3.50 per ton (bessemer) and $3.00 per ton (non-bessemer). No very accurate figures as to the amount of iron ore still remaining in the Lake district are available. A common

estimate, however, is that this reserve amounts to 1,500,000,000 tons of ore carrying over 50 per cent metallic iron. The ore below that grade, of course, is still very abundant.

Next in importance to the Lake district is the Southeastern United States. Here, particularly in east Tennessee, north Alabama and northeast Georgia, oolitic red hematites or "fossil ores" are extensively mined. These ores range, below water level, from 33 to 40 per cent in metallic iron, but are too high in phosphorus to be of bessemer grade. They can be delivered at the furnaces at a cost of 80 cents to $1.10 per ton, a price far lower *per unit of iron,* than any of the Lake ores. The extent of these red-ore deposits has been much underestimated by those unfamiliar with the district. In the course of my recent work in Alabama I have made a crude preliminary estimate of the available ore reserve, and think it safe to say that in Alabama alone there are still almost 1,000,000,000 tons of red ore above the thousand-foot level. The total red-ore reserves of Alabama, Georgia, and Tennessee are without doubt far in excess of those of the Lake Superior district. Brown ores occur in the same area, which with careful washing may average 48 per cent metallic iron, and sell for $1.50 to $2.50 per ton. These brown ores are also silicious and non-bessemer, so that the Southern industry has been toward making foundry irons.

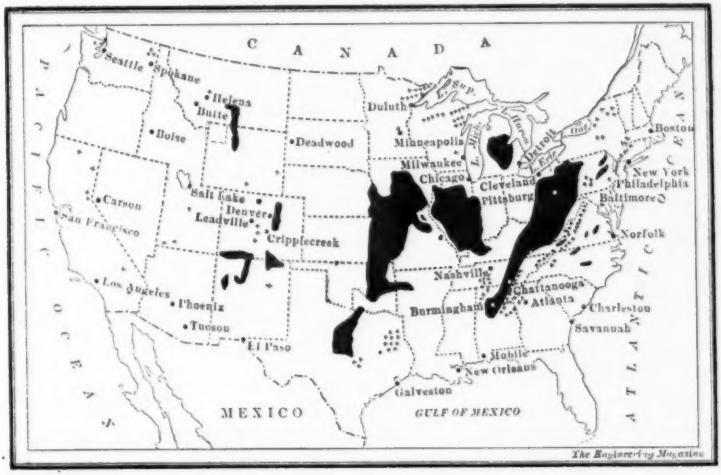


FIG. 2. MAP OF THE UNITED STATES, SHOWING THE PRINCIPAL COAL AND IRON DEPOSITS.

Open-hearth-steel plants are now, however, taking a fair share of the product, and in consequence many furnaces in the Southern United States now run on basic iron exclusively.

II. The Iron Industry of the United States.—It has been pointed out elsewhere that the location of the iron and steel industries is determined by the fuel supplies. In other words, under ordinary trade conditions, the iron ore will be hauled to the coal fields, rather than the opposite. This condition may be expected to prevail so long as fuel is used directly in the furnace. If the time ever comes when electric smelting is successful, we may expect to see iron and steel produced near the iron mines, where water power is usually plentiful.

At present, however, very different conditions prevail. Pennsylvania, for example, where only about half a million tons of iron ore are mined, makes eight million tons or more of pig iron. Ohio shows a similar disproportion between raw material and product; and Illinois, ranking third in its production of pig iron, does not mine a single ton of ore. The States of Minnesota, Michigan and Wisconsin, on the other hand, which furnish over three-fourths of the American ore, produce a very small percentage of pig iron.

It may here be noted that a considerable tonnage of Cuban and Spanish ores reaches the United States every year, the bulk of this importation being used by the Maryland Steel Co.

A glance at statistics of the pig-iron production of the United States, arranged by States, will serve to show the distribution of the iron industry.

PRODUCTION OF PIG IRON IN 1903 AND 1904, BY STATES.

[Long tons.]

State.	1903.	1904.	State.	1903.	1904.
Pennsylvania ..	8,211,500	7,644,321	Michigan	244,709	233,225
Ohio	3,287,434	2,977,929	New Jersey ...	211,667	262,294
Illinois	1,692,375	1,655,991	West Virginia..	199,013	270,945
Alabama	1,561,398	1,453,513	Kentucky	102,441	37,106
New York	552,917	605,709	North Carolina. }	75,602	70,156
Virginia	544,034	310,526	Georgia ..... }		
Tennessee	418,368	302,096	Connecticut ...	14,501	8,922
Maryland	324,570	293,441	Texas	11,653	5,530
Wisconsin ..... }	283,516	210,404	Massachusetts .	3,265	3,149
Minnesota ..... }					
Missouri..... }			Total.....	18,009,252	16,497,033
Colorado ..... }	270,289	151,776			
Washington ... }					

Complete detailed figures for 1905 are not available, but the production of pig iron for the first six months of 1905 is given in the table on the next page, comparison being made with the two halves of 1904.

	1904.		1905.
	1st Half.	2d Half.	1st Half.
Massachusetts and Connecticut.....	5,567	6,504	7,636
New York	250,980	354,729	550,208
New Jersey	121,294	141,000	165,991
Pennsylvania	3,713,867	3,930,454	5,226,691
Maryland	135,416	158,025	156,334
Virginia	186,037	124,489	240,672
North Carolina, Georgia and Texas	44,342	31,344	25,752
Alabama	800,256	653,257	743,547
West Virginia	103,153	167,792	149,016
Kentucky	17,516	19,590	32,793
Tennessee	165,883	136,213	195,757
Ohio	1,540,743	1,437,186	2,181,058
Illinois	798,221	857,770	979,157
Michigan	138,744	94,481	147,953
Wisconsin and Minnesota.....	104,437	104,967	184,234
Mo., Colo., Oregon and Washington	46,982	104,794	176,376
Total.....	8,173,438	8,323,595	11,163,175

The very marked increase in production, which began in March of 1905, is very noticeable in this comparative statement. Though detailed statistics for the entire year are not at hand, Mr. Swank informs me that the total production of pig iron for 1905 will probably be in the neighborhood of 23,000,000 tons, a figure far in excess of any previous year.*

The fact above noted, that iron furnaces are located in the coal fields, and not necessarily near the iron mines, is well brought out when the figures above given are grouped and compared with the production of iron ore. This has been done in the following little table:

	1903.		1904.		First half of 1905.
	Per cent. ore.	Per cent. pig iron.	Per cent. ore.	Per cent. pig iron.	Per cent. pig iron.
Lake Superior District.....	76.1	2.9	73.4	2.7	3.1
Southern United States.....	17.1	18.3	18.9	16.8	14.0
Central and Eastern United States...	4.9	77.6	6.4	79.7	81.4
Rocky Mountain States.....	1.9	1.2	1.3	0.8	1.4

The two districts which exercise most influence over the iron industry may be considered as centering respectively at Pittsburg and Birmingham. Conditions in the two areas are very different, in many respects. The Pittsburg district has cheap fuel of excellent quality; high-grade bessemer ores are shipped in quite cheaply from Lake Superior; and the States near the furnaces supply an active and enormous market for the finished product. The Birmingham district, on the other hand, has large deposits of low-grade, non-bessemer, but self-fluxing ores located within a few miles of the furnaces; cheap but

* The conditions in iron production are at present so stable that this estimate, based on ten months' production, is subject to very little probability of error.

not particularly good coals; and a very poor local market for finished products. Contrary to the general opinion, Alabama has little if any advantage over Pennsylvania in regard to labor. The negro is very inefficient, and the "poor white" is almost worthless; and though labor unions play little part in the Birmingham district, the pay of even common labor has increased 50 to 75 per cent in the past five years.

These conditions show on the cost sheet in very striking fashion. The fact that the Birmingham furnaces can secure all their raw materials—ore, coke and limestone—within a few miles of the plant makes possible much lower costs there than in Pittsburg. But these much lower costs do not necessarily mean a very much higher margin of profit. Until the bulk of Southern pig iron is used in Southern steel plants, and the steel sold to Southern manufacturers, most of the profits of Southern iron-making will go to the railroads.

The fact that costs are lower in Alabama than in Pennsylvania is well enough known, but the comparison of costs at a few selected furnaces in each State would hardly give results of value. Fortunately a broader basis for comparison is in existence.

The massive reports of the Twelfth Census (1900) contain a large amount of valuable and carefully concealed information on the cost of production of iron and steel. Careful examination shows that the data there given can be treated so as to give very exactly the cost per ton of the iron produced in the different States. This has been done for several important States, and the results are given below:

Cost of Production of Coke Iron, per Ton, 1900.

Alabama	$8.12
Tennessee	9.97
Illinois	10.12
Pennsylvania	11.23
Virginia	12.12

The items included in these costs are raw materials (ores, fuels, flux), wages, salaries, and repairs. This comparison of the costs in various States shows strikingly the strong position of the Birmingham district as compared, for example, with Pittsburg. The drawback to Alabama, of course, is that its local market is not extensive enough, so that much of its product must be shipped north and west in competition with the Pennsylvania and Ohio irons.

At present Pittsburg and Birmingham—using these localities as typical of their districts—are the controlling factors in the American iron industry. The part to be played by the West is still doubtful. Large deposits of high-grade ore are known to occur in the Rocky

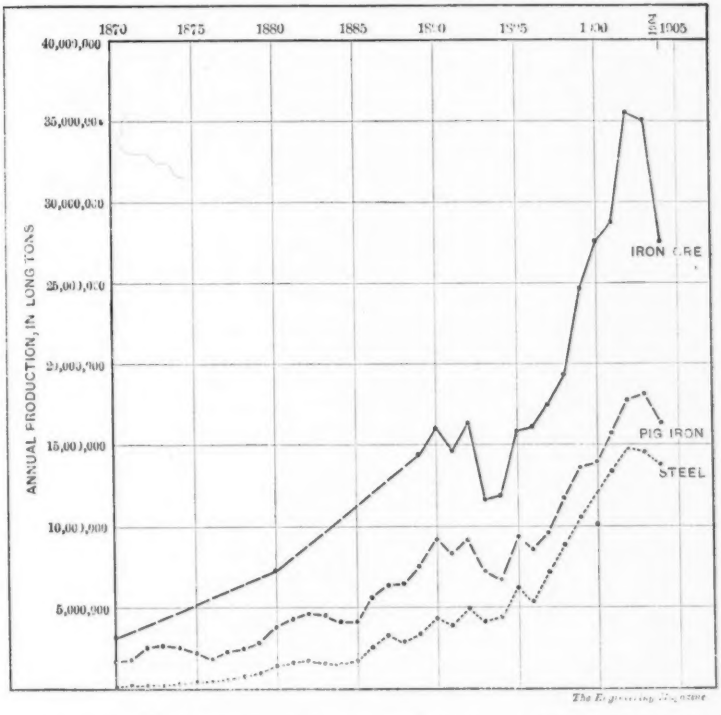


FIG. 3. AMERICAN PRODUCTION OF IRON ORES, PIG IRON, AND STEEL, 1870-1904.

Mountain and Pacific States, but fuel supplies are by no means so satisfactory, and as yet the local markets are undeveloped. The furnaces and steel plant of the Colorado Fuel and Iron Co., at Pueblo, Colorado, mark the first serious attempt to create a western iron center. An interesting feature of the 1905 situation was the purchase of 100,000 tons of Lake Superior ore by the Colorado Company. The great demand for iron and steel had over-run the immediate supplies from their own western mines, and necessitated the bold experiment of buying ore in Minnesota. The ore was sold on a basis of $2.15 per ton at the mine, and was carried 1,273 miles over four railroad systems for $4.50 per ton, thus costing $6.65 per ton at the Pueblo furnaces. In other words, each ton of pig iron made from this ore would cost about $11.00 for ore alone.

III. America's Rank as an Iron and Steel Producer.—The United States has for some time past led in the production of iron ores, of

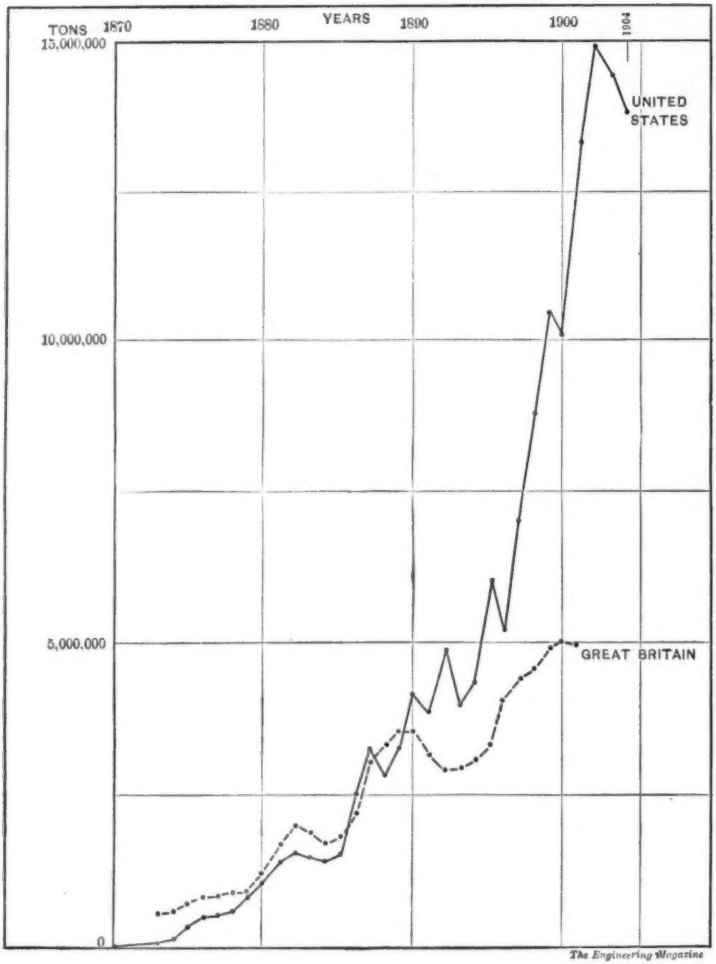


FIG. 4. AMERICAN AND ENGLISH PRODUCTION OF STEEL, 1870-1904.

pig iron, and of steel; and for the past few years has produced rather more than a third of the world's output of each of these materials. In all three Germany is a fairly close second, producing usually from 20 to 25 per cent of the world's total; while Great Britain is third with 15 to 20 per cent. The three leading nations are, however, less equally matched than this summary might seem to show, at least so

far as the probabilities of the future are concerned. The United States and Germany have shown fairly steady annual increases, not only in absolute tonnage but in percentage of the world's output; while Britain has practically remained stationary for a decade or more. The three nations above mentioned produce together three-fourths or more of all the iron and steel. The remainder of the output is divided among many countries, France, Russia, Austria and Belgium being the more prominent of these minor producers. Canada, despite a heavy bounty granted by the Dominion Government, is still of little importance in the iron industry. Her iron ores are of excellent quality, but the best deposits are located far from the Canadian coal mines.

In the following table the world's production of iron ore, pig iron, and steel is given in some detail for the year 1903, the last for which complete statistics are available. The production of the leading nations for 1904 is, however, on record; and these have been added.

	1903.			1904.		
	Iron ore.	Pig iron.	Steel.	Iron ore.	Pig iron.	Steel.
U. S.	35,019,308	18,009,252	14,534,978	27,644,330	16,497,033	13,859,887
Gt. Britain	13,715,645	8,935,063	5,134,101	13,774,282	8,562,658	5,026,879
Germany .	21,230,650	10,085,634	8,801,515	22,047,297	10,103,941	8,930,291
France ..	6,219,541	2,840,517	1,885,000	.....	2,999,787	2,080,554
Belgium .	184,400	1,216,500	969,230	.....	1,307,399	1,083,000
Austria ..	3,269,175	1,428,158	*1,193,000	.....	.....	.....
Russia ...	4,218,600	2,486,610	2,410,938	5,272,300	2,978,325	2,811,948
Sweden .	3,677,841	506,825	318,897	4,084,647	528,525	332,571
Spain ...	8,304,153	302,657	199,642	.....	.....	.....
Italy	374,790	75,279	187,642	.....	.....	.....
Canada...	235,977	265,418	181,514	312,286	270,942	148,784
Cuba.....	624,858	.....	.....	.....	.....	.....
Other countries	3,780,435	248,744	66,112	.....	.....	.....
					.....	.....
Total..	100,255,373	46,400,657	35,882,288			

* 1902.

Of the two years whose statistics are given in the above table, 1903 was prosperous rather above the average, while 1904 was a year of low prices and extreme depression in the American iron and steel industries. The year just past, however, showed a very active market and it seems probable that the present prosperity will last well into 1906. High prices for part of 1906, at least, are assured, for many large purchasers of ore and pig iron, for delivery in the spring, have already been made at prices highly remunerative to the miner and furnaceman.

So far as can be learned, other countries have not shared equally with the United States in the remarkable advance which took place in 1905; and whenever comparative statistics for that year are available, it will probably be found that America produced 40 per cent or more of the world's output of iron ore, pig iron, and steel.

THE UTILISATION OF LOW-GRADE FUELS FOR STEAM GENERATION.

By W. Francis Goodrich.

In a preceding paper, published in this Magazine last month, Mr. Goodrich took up in detail the results secured in the practical use of various small and low-grade fuels under working conditions in the power plant. In the concluding section, now presented, he deals more particularly with the adaptations of the boiler furnace and other appliances to the burning of low-grade combustibles, though in developing the subject he exhibits the results secured with some fuel materials of considerable local importance and recently the subject of much interested inquiry.—THE EDITORS.

WHENEVER a fair evaporative efficiency is required from a boiler to be fired with a fuel containing over 30 per cent of incombustible, it may be submitted that the external firebrick cell is the best method of effecting proper combustion. With the average boiler of either the Lancashire or water-tube type the grate area is not sufficient, and with boilers of both types the close proximity of cooling surface in the form of plates and tubes respectively adds materially to the difficulty presented in burning such fuels. With a water-tube boiler having an extra large grate and a modified setting, the conditions are certainly more favourable; but the ideal conditions are presented in the external firebrick cell.

Under such conditions it is possible to provide a grate area which is otherwise impracticable. Taking for example a Lancashire boiler 30 feet by 8 feet which with internal furnaces would have a grate area of 38 square feet—that is, grates 6 feet in length by 3 feet 2 inches wide. In order to fire this boiler with the gases from a very low-grade pit-bank refuse, an external firebrick cell having either 50 or 75 square feet of grate area might be provided. With this large grate area and artificial draught it is possible to burn a very considerable quantity of inferior fuel, obtaining an evaporative efficiency from the boiler which could not possibly be secured under any other conditions.

With ordinary internal furnaces in a large Lancashire boiler, it requires a good natural draught and an unusual activity upon the part of the fireman to burn 10 hundredweights of Welsh steam coal per hour. With an external cell having 50 square feet of grate, placed in front of a similar boiler, it is an easy matter to burn 30 hundred-

weights of pit-bank waste per hour; the latter fuel may only have an evaporative value of 4 pounds of water per pound of fuel, but burned at a greatly increased rate of combustion on an increased grate area it becomes a simple matter to evaporate more than 10,000 pounds of water per hour with one Lancashire boiler 30 feet by 8 feet.

For the past three years a very poor colliery shale has been thus disposed of at some two or three Yorkshire collieries, and unpromising as this fuel would appear to be from the appended figures it has nevertheless proved to be quite suitable for obtaining the maximum evaporative efficiency from the boiler.

SHALE—GLASS HOUGHTON & CASTLEFORD COLLIERY CO.

(A)	SHALE—SIZE, 3-INCH SQUARES.	
	Calorific value	1,933 B. T. U. per pound.
	Volatile matter	16.60 per cent.
	Ash	11.6 per cent.
(B)	SHALE—SIZE, 6-INCH SQUARES.	
	Calorific value	2,416 B. T. U. per pound.
	Volatile matter	20.16 per cent.
	Ash	63.80 per cent.
(C)	SHALE—SIZE, 3-INCH SQUARES.	
	Calorific value	6,573 B. T. U. per pound.
	Volatile matter	25.73 per cent.
	Ash	19.43 per cent.

With the external firebrick cell the use of forced draught is essential; up to the present, indeed, it has been clearly demonstrated even with internal furnaces that for burning the lowest grades of fuel forced draught is far more suitable than induced draught. The poorer the quality of the fuel the more clearly has it been shown that forced draught, provided either by means of a centrifugal fan or steam-jet blowers, is far better adapted for the efficient combustion than is induced draught. If for purposes of argument we select what is perhaps the very lowest grade of fuel used in any considerable quantity, that is, towns' refuse—we are bound to admit that while forced draught has amply fulfilled all requirements under a great variety of conditions, induced draught wherever tried has failed to satisfy.

In connection with a large and recently erected destructor installation in India, forced draught has been provided in addition to induced draught, and this in spite of the fact that most elaborate arrangements are made for the preliminary drying of the refuse. This course was doubtless dictated as the result of experiments in a London works, where it was found that induced draught alone was not suitable for the efficient cremation of sorted towns' refuse.

The smoke-abatement experiments with native fuels recently conducted on behalf of the Indian Government in Calcutta by Mr. Frederick Grover conclusively proved the value of the Dutch oven, or

semi-external furnace, in connection with water-tube boilers. Low-grade slack fuels with a high percentage of volatile matter were burned without smoke under such conditions, whereas it was shown that the same fuels could not be consumed smokelessly with such mechanical stokers as have been adopted in Calcutta. Here we have demonstrated the necessity for and the value of what my good friend Mr. W. H. Booth would term "common-sense environment." As I have stated many times, I am in cordial agreement with Mr. Booth; it is impossible to burn very low-grade fuels containing a high percentage of volatile matter to the very best advantage, and with a complete immunity from smoke troubles, unless they are burned in an incandescent firebrick cell.

It has been urged by some that the number of heat units absorbed by the large area of brickwork is excessive, and that this represents a serious loss in actual heat transmitted through heating surfaces; but there is really little in this contention. The actual heat value absorbed in the brickwork is recouped again and again by the rapid ignition of the gases and the intense and well sustained temperature of the gases passing to the boiler.

Objection has been made to the external firebrick furnace, because it is feared that it would be costly in maintenance and upkeep. While it is true that such a furnace may prove very costly if badly designed and constructed, or if very poor material is used in construction, it is equally true that if the best workmanship and materials are employed such a furnace will cost no more for maintenance than many steam users cheerfully pay for firebars alone.

External furnaces cannot be recommended under all conditions and for every class of fuel; but it is beyond all question that in this type of furnace is presented the very best method of burning, for steam generation, such fuels as wood, peat, tan, coal with a heavy percentage of volatile matter, pit-bank and colliery waste, and all coal of a highly refractory nature and containing more than 35 per cent of incombustible. It is idle to argue that small coal, containing upwards of 35 per cent of incombustible or partaking of a shaly nature, can be burned in any internal boiler furnace, either machine or hand-fired, while enabling the boiler to be worked well beyond its rated capacity. The conditions are all against such a result being obtained, and although it may be glibly promised it cannot be done excepting on a short test with an expert fireman.

If the steam user is content to work his boiler up to one half (or even less) of its rated capacity, then it is possible, with suitable fur-

naces, to burn a very poor fuel—always providing that the fireman can be persuaded to do his part. Owing to the limited grate area, however, and the necessity for frequent cleaning of the fires, due to the presence of a high percentage of clinker, the work is very heavy.

So far as Great Britain is concerned, much yet remains to be done in the satisfactory burning of wood as a fuel. In the wood-working industry comparatively little has been done in this direction so far, and average British practice when compared with that in Finland, for instance, approaches the ludicrous. We have often been reminded that next to coal, wood is the staple fuel; and when its calorific value is borne in mind, it is indeed remarkable that so little has been accomplished in the burning of wood and wood-waste, under such conditions as ensure the maximum fuel value being obtained.

In a great number of works in Great Britain, wood is being wastefully burned in ordinary furnaces designed for good coal. In some cases wood alone is burned, in other cases it is mixed with coal, either large or small; indeed, it may be fairly observed that in many works good coal is being burned to consume the wood—a practice not at all uncommon, and entirely due to the ignorance of the British steam user, who too often is quite satisfied if he can generate such steam as he requires under any circumstances.

In many saw mills, etc., sufficient wood waste is available to provide the whole of the steam power required if such fuel is burned under the best conditions, and in this industry needless to add it would be very beneficial if coal accounts could be entirely closed. Such a desideratum, however, will be reached only by burning wood waste under those scientific conditions which will ensure the maximum value being secured, and fully utilised. The nature of the material is such that it can be best burned outside of the boiler in an external cell or furnace. The large grate area, the facilities for introducing heavy charges of such fuel with the minimum of effort, the trapping of the fine dust in a chamber outside of the boiler, together with the large area of incandescent firebrick lining—these present the really ideal conditions for burning wood or wood waste as a fuel. Under such conditions it is possible to burn a large quantity with the minimum of labor cost. Flue cleaning—a constant source of trouble when wood is burned in internal furnaces—is practically done away with; the smoke trouble does not arise; the incandescent firebrick walls ensure rapid ignition of the gases, and with satisfactory working, clear flame only comes into contact with the heating surface of the boiler.

Although comparatively little has been accomplished in this direction so far, enough has been done to show clearly that when sufficient wood or wood waste is available the use of coal can be entirely dispensed with.

Peat is a fuel which has been but little used for steam generation, largely because where such fuel is found in abundance, generally speaking, little if any outlet exists for its utilisation. It is nevertheless a very useful fuel, as will be evident by referring to the appended figures of a test carried out at the Sutton Electric Traction Station, County Dublin. It is but fair to add that in this instance the furnaces were not designed for dealing with such a fuel, being of the ordinary natural-draught type, the grate area corresponding to that which would be employed for a fuel of much higher calorific value. The tabular statement of the test appears on the opposite page.

The peat was absolutely pure, being macerated and dried by a patent process and costing at the factory six to seven shillings per ton. It will be clear upon referring to item number 36 in the table that had an economiser been installed, the evaporative efficiency of the fuel would have been at least 15 per cent higher.

Peat may be classed among those fuels which can be most efficiently employed for steam generation by being burned in an external firebrick cell, and under such conditions no difficulty would be experienced in obtaining a boiler efficiency equivalent to the best modern practice with expensive steam coal.

Unfortunately, peat (like Irish anthracite coal) is used to only a comparatively small extent in that country. Where these fuels are available in enormous quantities at a very low cost there are but few works requiring fuel, and while many works may be found within a reasonable radius, no facilities exist for cheap transportation of the fuel. Some years since, when visiting the Irish anthracite collieries, I found that coal for steam generation was actually being conveyed twenty miles by road.

During the past few years, mechanical stokers have been extensively adopted, and while they have by no means reached that perfect stage so persistently claimed for them by their makers, much excellent work has been done. Those who have closely followed steam generation in Great Britain during the past few years, will have observed that in the large cities and towns the smoke nuisance has been appreciably lessened, and this notwithstanding the ever increasing use of small bituminous fuels, and the fact that a far higher boiler efficiency is now demanded than was the case a few years since.

EVAPORATIVE TESTS ON PEAT FUEL IN LANCASHIRE BOILER AT SUTTON ELECTRIC TRAMWAY POWER HOUSE, CO. DUBLIN.

1.	Date of Test	Nov. 1st, 1904.
2.	Between the hours of	10.30 P. M. and 12.30 A. M.
3.	Duration of Test	2 hours.
4.	Mean absolute Boiler Pressure	176 lb.
5.	Corresponding temperature	371° F.
6.	Mean Temperature of Feed Tank	52.2° F.
7.	Mean Temperature of air in open	51° F.
8.	Mean Temperature of air in Stokehold	56° F.
9.	Mean Temperature of Feed Water Heater Outlet	115.6° F.
10.	Increase of temperature due to Feed Water Heater	65.4° F.
11.	Factor of evaporation (basis 4-9)	1.1513.
12.	Total heat in 1 lb. of steam at 4 from 32° F.	1,195.14 B. T. U.
13.	" " " " " " water " 6 " 32° F.	18.3 B. T. U.
14.	" " " " " " " " 9 " 32° F.	83.53 B. T. U.
15.	B. T. U. added by heater per lb. 14-13	65.23 B. T. U.
16.	B. T. U. added by boiler per lb. 12-14	1,111.61 B. T. U.
17.	Grate area in square feet	35.
18.	Heating surface in square feet	902.
19.	Ratio of grate to boiler heating surface.	1 to 25.7.
20.	Total peat used during test	3,444 lb.
21.	Peat used per hour	1,722 lb.
22.	Peat used per sq. ft. of grate per hour	49 lb.
23.	Coal used per sq. ft. of Lancashire practice	18 to 21 lb.
24.	Peat used per hour per sq. ft. of boiler heating surface	1.9 lb.
25.	Total water used	11,910 lb.
26.	" " " per hour	5,955 lb.
27.	Water per sq. ft. of grate per hour	170 lb.
28.	Water per sq. ft. of grate usual Lancashire practice	160 lb.
29.	Water per sq. ft. of boiler heating surface per hour	6.6 lb.
30.	Water per sq. ft. of boiler heating surface usual Lancashire practice	3 to 6 lb.
31.	Water evaporated per lb. of peat	3.45 lb.
32.	Equivalent from and at 212° F.	3.97 lb.
33.	Ashes formed	67 lb.
34.	Percentage of ash to combustible	1.9 per cent.
35.	Average draught in chimney	.53 inches.
36.	Average temperature chimney base	565° F.
37.	Average temperature above boiler damper	Not ascertained.
38.	Cost of peat per ton	Assumed @ 12 shillings 6 pence delivered.
39.	Cost of evaporation 1,000 gallons	Say 15 shillings 6 pence.

Perhaps the most important improvement in connection with machine-fired furnaces during the past few years has been the combination of artificial draught. This combination has been valuable: (1) in bringing within the range of the mechanical stokers many small and inferior fuels, the use of which was previously restricted to hand-fired furnaces; (2) in enabling a far greater evaporative efficiency to be obtained from boilers; and (3) in assuring a greater certainty in the prevention of smoke, due to the efficiency of the air supply.

Ten years since, in order to work a coking stoker smokelessly, it was imperative to reduce the output of the boiler down to one-half of its rated capacity, and it was a common experience to find a Lancashire boiler 30 feet by 8 feet giving an evaporation of from 3,000 to 4,000 pounds per hour; now, a boiler of the same size fitted with coking stokers and forced draught and burning a similar fuel will evaporate from 12,000 to 14,000 pounds per hour, while keeping a clean chimney.

With sprinkling stokers, and artificial draught, a still heavier evaporative efficiency may be obtained from a boiler of similar size, but not with an entire freedom from smoke; and wherever the chimney draught is sharp, with stokers of this type, fine dust and grit is deposited in the flues and discharged from the chimney.

Experience has clearly shown that for smokeless working together with heavy boiler duty and a good fuel efficiency, the mechanical stoker working with natural or chimney draught alone cannot compete with the modern combined stoker and artificial draught.

For smokeless working the coking system is absolutely essential. For forty years past this type of stoker has been pre-eminent in this respect, and it will continue to hold its own. With water-tube boilers, the chain-grate stoker with modern improvements has a very satisfactory record, but unlike other modern coking stokers a small fuel of good quality, clean and practically free from dust, is demanded.

As at present arranged, the chain-grate stoker must be used either with natural draught, or induced draught; there are difficulties in the adaptation of forced draught, and so far as I am aware, this combination remains yet to be tried.

While for many years past slack coal has been burned with mechanical stokers, it is only within recent years that any machine-fired apparatus has been so designed that fine slacks with a good proportion of dust can be successfully burned. I am well aware that for a quarter of a century past it has been claimed for the mechanical stoker that it would satisfactorily deal with small fuels which could not be burned with any other form of furnace. In so far as many small and low grade fuels are concerned this was a mere claim and nothing more. It is only within the past few years that the mechanical stoker has been able to compete seriously with hand firing with many small fuels, and such a change has only been effected by the addition or combination of artificial draught with machine firing.

There are a wide range of fuels which demand a certain manipulation and treatment together with a definite intensity of draught, for

their successful use, and it is obvious that the required manipulation may be given more satisfactorily by manual labor in hand firing than is possible with any machine-fired apparatus.

When everything possible has been said in favor of machine firing, we are still brought face to face with the fact that the mechanical stoker is limited in its range of usefulness. There are many fuels which cannot be successfully dealt with by any machine-fired furnace yet devised; I may mention just a few such fuels—towns' refuse, peat, wood, pan breeze, coke breeze, colliery waste, and the lowest grades of coal.

One is constantly asked whether towns' refuse cannot be mechanically fed; but up to the present there is no reason to suppose that such material will ever be machine fired. Machine firing is essentially suitable for an homogeneous material only, and there would appear to be but little prospect of any appliance being devised which will feed ashes, straw, mattresses, paper, and the hundred and one articles which go to make up average towns' refuse. But even assuming that suitable apparatus may be devised, it must not be forgotten that the mechanical process must inevitably cease with the feeding, because experience has clearly demonstrated that when such material is once on the grate it must be left alone until it is removed in the form of clinker. Firebars with a reciprocating motion cannot be used; any attempt to move such material renders active combustion impossible; if the mass is moved the fire is extinguished.

In this article I have endeavoured to show that many very low-grade and cheap fuels are not only well worth burning for steam generation, but also how such fuels may best be dealt with to ensure the realisation of their maximum calorific value.

A really first-class fireman, not a mere thrower-in of fuel, is a valuable servant; some of these men can with the shovel show results which cannot be improved upon by any machine-fired apparatus yet devised. Such firemen are, however, rare; the average fireman makes no secret of the fact that he prefers the very best fuel, and if it is to be obtained he will have it. Economic steam generation possesses no attraction for him; he prefers an expensive fuel because it requires the minimum of exertion on his part.

These are points which the steam user has often failed to grasp, and he would do well to bear in mind when he is disposed to reduce his fuel cost to the minimum, that the fireman is the very last individual who should be consulted thereon.

THE SQUARE DEAL IN WORKS MANAGEMENT.

By O. M. Becker.

I. THE COMMON-SENSE OF THE MANAGEMENT OF MEN.

It is regretfully admitted by many managers that while machinery has been brought to a high degree of perfection, *men* are almost as hard to manage as ever. Yet there are shops where labor troubles are scarcely known. What are the methods or what is the policy securing such happy results?

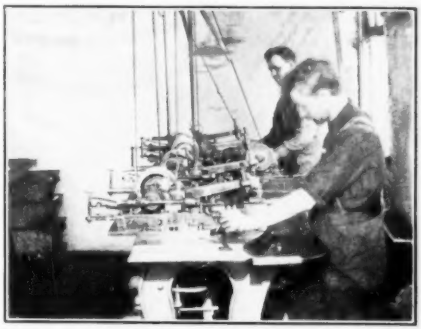
This is the question which Mr. Becker proposes to answer in the series of articles of which this is the first. His method will be chiefly that of evidence—by bringing forward actual examples of successful works and factories all over the country, and showing just what they do and *just how it pays.*

He has been intimately associated with one of the best manufacturing plants in the United States, and he writes as a practical man, for practical men. The present paper is chiefly introductory. The succeeding ones will take up: "What Can Be Done with the Plant"; "What Can Be Done with the Workmen"; and "The Auxiliary Methods of Successful Labor Employers."—THE EDITORS.

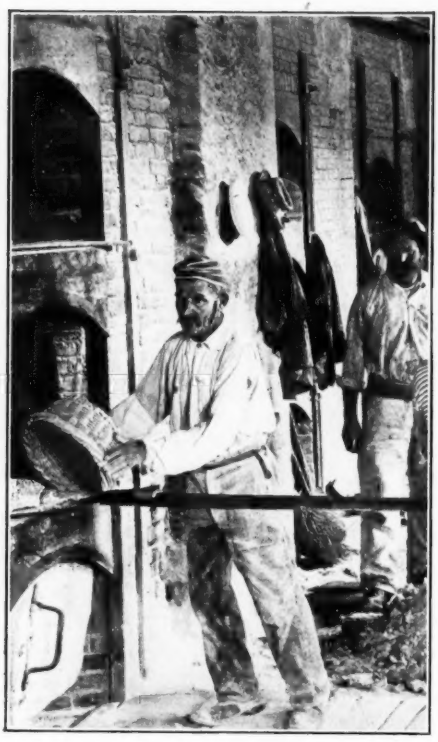
IN recent years there has been a growing tendency in the business and industrial world to recognize an ethical and social relation between employer and employed, and to acknowledge a moral test which the employer is bound to apply to that relation in the conduct of his business. Previous to the introduction of hand- and foot-power machinery, about a century and a half ago, practically all production was manual; and where the relation of employer and employed existed at all, it was of a close and personal nature. During the period following the advent of machinery—the period of the home factory—the owner of the machine was still in close personal relationship with those assisting him in his manufacturing enterprise, because the workers were chiefly members of his own family. The application of steam power to the driving of machinery, however, quickly brought about a remarkable change. The steam engine made possible the factory, with its concentration of power and the accompanying aggregation of operatives. Manifestly, the creation of a large class of wage earners (which naturally was contemporaneous with the development of the factory system) tended to minimize the possible points of contact between the workingman and the man for whom he worked. It remained for the modern factory system and corporate organization—based upon the production of everything upon the large scale and the minutest possible subdivision of labor—by the massing of great numbers of workers practically to close the door to any personal relation between the capitalist and the workingman.

"The operator might as well have his arm riveted to one of the machine's moving parts, so thoroughly is he become part of it."

Along with the passing of the small factory and the possibility of a personal contact of operator with operative, came also the practical displacement of the skilled mechanic by the piece worker—the machine tender who is skilled in doing but one infinitesimal part in the productive process. The development of machinery, undoubtedly one of the great blessings of mankind, has like other important advances in civilization left in its wake much that is evil. The machine tool as now designed tends to make of its tender merely a more or less mechanical attachment—a sort of additional lever or gear wheel endowed with a modicum of intelligence. Standing all day before his shrieking, chattering, nerve-racking machine, feeding into it for ten hours the little or big pieces as the case may be—one, two, five, ten, thirty thousand before the tension is relieved—the operator might just as well have his arm riveted to one of the machine's moving parts, so thoroughly is he identified with and become a part of



"The man comes to live a life itself so mechanical as to leave little inclination for the social and intellectual activities."



THE MAN PAST FORTY.

"The only thing for him is a gradual descent into other work requiring less expertness and less strenuousness, and consequently commanding less pay."

it. Under such conditions what could be more obvious than that the man tends to become lost in the machine, and ultimately comes to live a life itself so mechanical as to leave little inclination for social and intellectual activities?

The tendency now is still further to speed up machinery; and it may therefore be expected, in spite of the belief of some that the limit of endurance has been reached in many cases, that the operative will gradually be worked up to a still higher speed and at a higher pressure than now. The disposition is more and more to replace machinery with other of later and more efficient design, so as to get the utmost possible in quantity and quality of product in the shortest practicable time. That is to say, as soon as it becomes apparent that a particular machine is no longer doing as efficient and therefore as economical work as another might, it is at once thrown into the scrap pile and the new one installed. As a part of the same policy—possibly a necessary part under present industrial conditions—there is a growing disposition to eliminate the old men among the operatives. For, inasmuch is the man is coming to be a part of the machine he tends, and like it is worked up to the highest limit of speed and endurance, he after a time shows signs of wear; he passes the critical period of efficiency and cannot longer maintain the tremendous rate at which he has been running. Under such circumstances he is

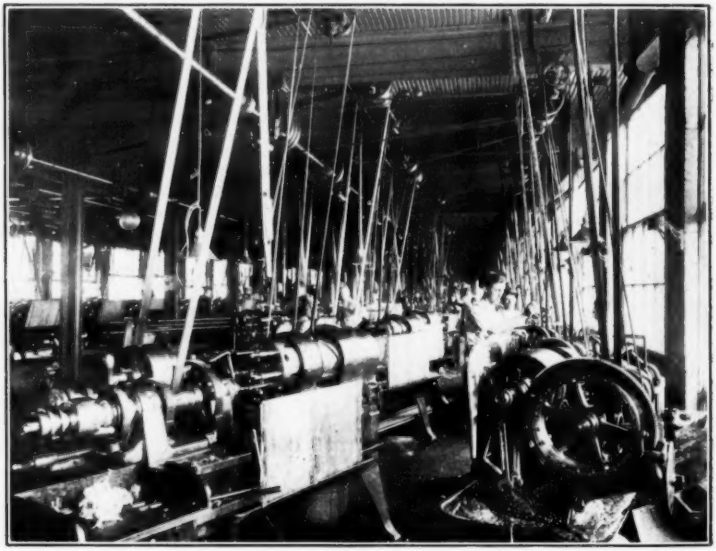
no longer profitable to the capitalist and is therefore to be sent to the scrap pile along with his machine, and his place filled by a younger man. Startling evidence of such a disposition is found in the recent dismissal of many old employees by several of the great corporations. They had passed the "dead line." Younger men could be had cheaper, and with a little practice became more efficient. Similar evidence is to be seen at the employment office of practically every large business house. The man out of a job and on the shady side of forty stands little chance indeed of selection for any position, unless the supply of younger men similarly qualified (or even if not qualified, apparently promising) be considerably less than the demand. The only thing for him is a gradual descent into other work requiring less expertness and less strenuousness, and consequently commanding less pay.

Not only is the "dead line" an established fact in industry; but it is being drawn closer and tighter. A few years ago, forty-five was considered the limit of the average man's greatest productive efficiency. Forty, and even less, is now regarded as the critical point,

HOMES FOR OLD AND INCAPACITATED EMPLOYEES, BOURNEVILLE, ENGLAND.
Showing the provision made by Cadbury Bros. for taking care of wear and depreciation in the human machinery of their plant; the worn-out workman is honorably retired, not cast into the scrap pile with his machine.

doubtless with good reason. It is certain that as a machine is used the more strenuously, the more rapidly it wears out. The human machine, more delicately constructed than any product of human hands, is even more susceptible to wear; and if forty-five was ten years ago the critical point in the life of a producer, doubtless forty would at present closely represent the same productive capacity, because during the past ten years there has been a very marked speeding up all along the industrial line. Where the dead line will be drawn in another ten years remains to be seen. Let us hope that there will be a reaction favorable to the man with the experience. There are already intimations that such a reaction will come about—but whether through still further development of machinery, or through a more general recognition of the sacredness of human life and human mind, is not yet apparent; possibly through both agencies.

Now, whether it be of cold insensate metal or of human brawn throbbing with life, it is certainly good "business," when a machine has reached a point where it is no longer at its highest efficiency, to put it to less exacting service, or to retire it from service entirely. Carried out under conditions that take into account the ethics of the



"THE AUTOMATIC-MACHINE ROOM WHICH PORTENDS THE COMING OF THE ALL-BUT-MANLESS SHOP."

Automatic screw-machine department, National Cash Register Co., Dayton, O.

A DANCE EVENING FOR A GROUP OF CORE-MAKERS, McCORMICK WORKS OF THE INTERNATIONAL HARVESTER CO., CHICAGO.

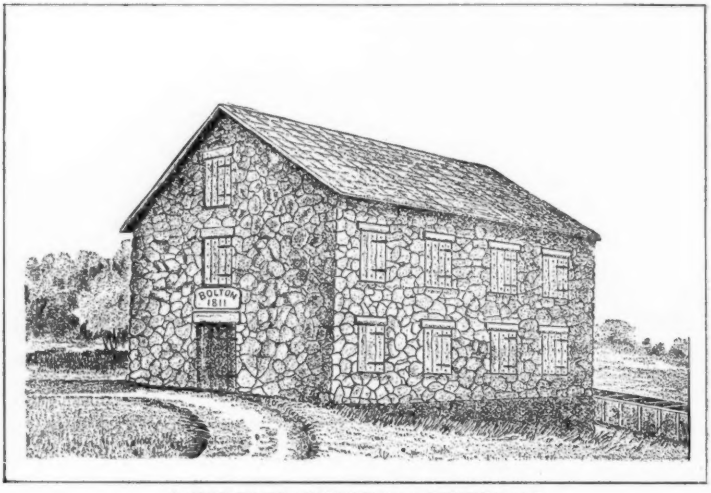
It provides healthy social entertainment for the boys and girls, using a room ordinarily devoted to factory purposes. The clean conditions thus afforded replace and exclude the appeal which the highly-spiced attractions of the dance hall are otherwise too apt to make to young workers in the high-strung life of the shop.

case, there can be no valid objection to such a course applied to animate productive machinery. But the modern industrial system has as yet made no adequate provision for doing this. There are sporadic instances—a few in the United States, a few in England, and more in Germany and France. The situation in Germany probably comes closer to an equitable adjustment than elsewhere by reason of the compulsory and therefore universal system of pensions and disability payments by employers.* But in general little attention has been paid to this principle, a principle really fundamental to a safely conducted business, to wit: making provision for the depreciation of human machinery as well as for the other equipment of a plant. A business that cannot do this, or whose promoters will not do it, is safe neither for the investor nor the man employed in it.

The displacement of really skilled workmen by the almost automatic operations under the "piece-work" system; the dependence of

* This feature of the German industrial system, together with many other striking points in the modern economic policy of Germany, are more fully brought out in a keen analytical study of "The American and the German Peril," by Louis J. Magee, the first part of which appears elsewhere in this number of THE ENGINEERING MAGAZINE.—THE EDITORS.

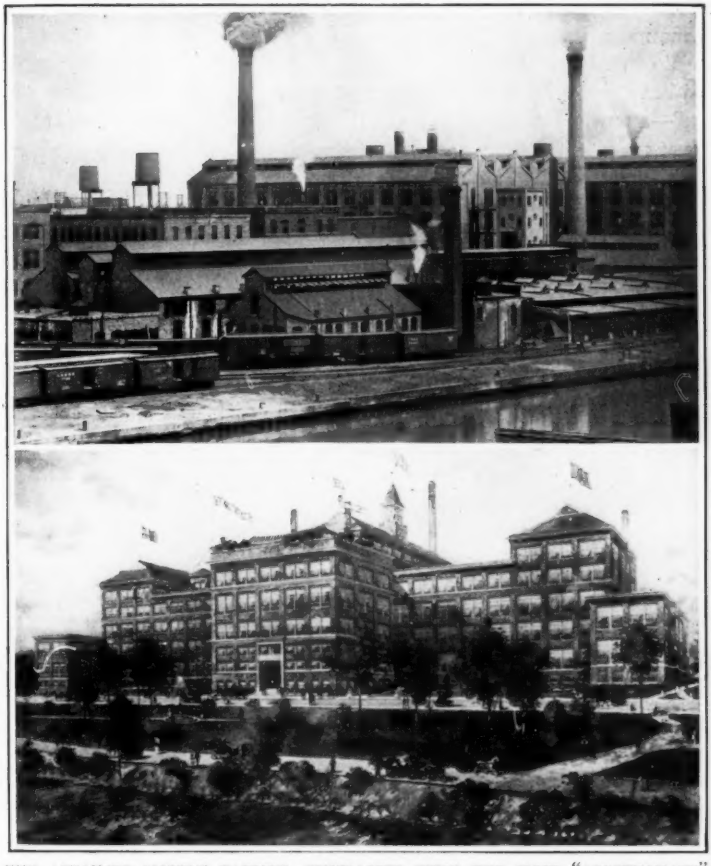
the operative upon the machine; the segregation of workers in industrial centers; the constantly growing tendency to work machines and men at their topmost speed—all these things taken together have one inevitable result. The worker is drained of his vitality, and after a day's work not only has no energy left for living during the remainder of the twenty-four hours anything like the intellectual and social life that should be possible to him, but after a few years becomes a worn-out relic of this modern industrial system, a burden to society and to himself. There is here a tremendous problem, the satisfactory solution of which is important not only to the worker, but to the captain of



A TYPE OF THE FACTORY OF A CENTURY AGO.
Bolton Mill, the first cotton mill in Georgia, built in 1811.

industry as well; for however much machinery may be made to displace human strength and skill, there still remains the necessity of intelligent operation and tending of that machinery; so that unless provision be made for the preservation and development of a class of intelligent operatives, the industrial system must inevitably fall of its own weight.

That there is such a problem, insistently demanding solution; that the human machinery is after all the most important part of a producing or trading plant; that there is possible an ideal relation between the man who works for wages and the man who pays the wages; that industry and trade are not on a safe basis unless there be made provision for both present and future welfare of the worker—all this



THE ADVANCED MODERN FACTORY, CONTRASTED WITH THE OLDER "ACCRETIONARY" TYPE OF CONSTRUCTION.

The buildings of the Natural Food Co., regarded by many as showing probably the most beautiful and thoroughly adapted example of factory architecture in the world, are illustrated in the lower view. They represent, perhaps, an ideal which comparatively few capitalists are inclined to approach. The upper picture exhibits the more usual present-day aggregation of buildings—ugly, crowded, and of varying degrees of adaptability to the purposes for which they are used.

has not yet dawned upon the world of business taken collectively. Nevertheless there have been men who saw clearly, almost from the time the factory system began to develop, the necessity for taking into account propositions so fundamental and so essential to industrial and commercial progress; and there is ample evidence that at the

present time there is coming to be a lively interest and a desire for information among thoughtful employers as well as among students of social conditions. A sufficient number have taken hold of the problem and have worked it out far enough to show beyond cavil that "altruism"—a term which sifted down to its intended meaning, signifies only a just regard for others, and is practically equalled in homely phrase by "the square deal"—not only is a factor in business, but is an important factor, whether viewed with reference to self-interest or to sound ethics. Many others are looking askance, desiring to fulfil their obligations, but hesitating for fear of making mistakes; and still others hesitate to risk additional capital without the certainty of tangible return. On the whole, however, the situation is very encouraging.

FACTORIES OF THE N. O. NELSON MANUFACTURING COMPANY, EDWARDSVILLE, ILL. Simplicity, order, architectural adaptation to purposes; ample room, with the vacant spaces plainly but neatly sodded and planted. A type well suited to suburban or country location.

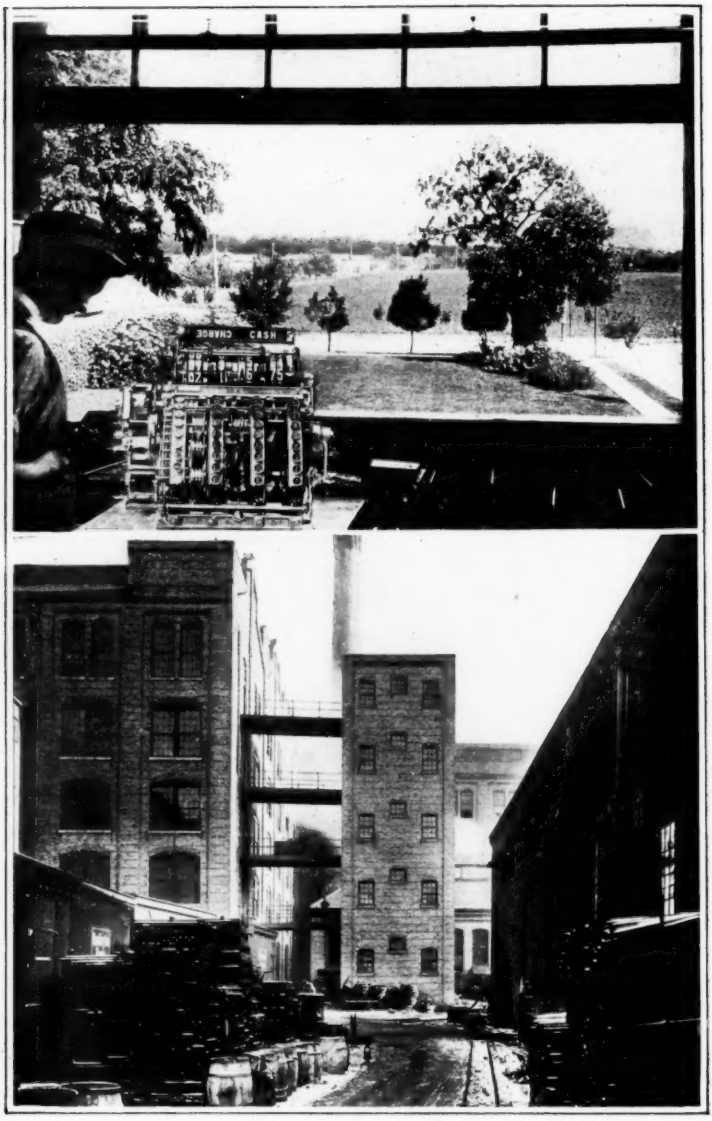
The first to make a serious effort looking to the amelioration of the hard conditions under which factory operatives have worked was Robert Owen. First a cotton-mill superintendent and later an owner, Owen in the early years of the last century undertook to bring about a change in the social and moral conditions of his employees. However much modern factory and industrial conditions may be decried as lacking in human sympathy, in the first years of the factory period they were infinitely worse. At that time the oftentimes inhuman greed of the mill owners had not yet been restrained by effective factory legislation, and conditions were frequently so atrocious and revolting as to be scarcely believable.

In 1799, on coming into the management of the mills at New Lanark, Scotland, Owen set about working a regeneration in his com-

munity, not indeed without bitter opposition from the very people to be benefited. His first step was to provide for each workingmen and his family at least two rooms to live in. Large families had been accustomed to live in wretched hovels containing often not more than a single room, and the filth was utterly beyond description. The second step was to remove the filth that had accumulated in the streets and to encourage cleanliness and proper sanitation in the homes of the village. Under these vile conditions, as may well be imagined, intelligence and morality, were all but unknown. Shiftlessness, drunkenness, and poverty prevailed. Under the new *régime,* however, things shortly began to look a little different. Streets were no longer allowed to become obstructed by dung hills, drainage was provided, and the village began to take on a thrifty appearance.

THE MODEST HOME OF THE PROPRIETOR OF A LARGE MANUFACTURING PLANT.
Residence of Mr. N. O. Nelson, who lives among his employes in the industrial town he has built up outside but within easy reach of a large city, at Le Clair, Ill.

Schools were practically unknown in the community, so Owen built one and opened for the education of the children, the first infant school in Great Britain. A hospital for the sick and aged; a sort of club house for dancing, music and entertainments; a kitchen and eating house; facilities for washing and cleaning up after work; a library, and a lecture room—all these were provided for his employees, many of them the while cursing the new superintendent and threatening him



A CONTRAST IN OUTLOOK FROM THE WORKER'S BENCH.

The pleasant prospect from the windows of the National Cash Register Co.'s shops, Dayton, Ohio, is compared with the view (by no means the worst possible) from the window of an average factory.

with dire punishment for presuming to interfere with their established customs and personal freedom. At the same time stores were opened for the sale of everything needful in the village, all of superior quality and at reduced prices, with the result that the cheap retail shops whose chief business had been the sale of spirits were driven out. More important than all the other innovations, however, was the establishment in the New Lanark mills of what was practically a ten-hour work day with adequate wages—the first effort of the kind in the manufacturing industry. Of equal importance was the reform

CANNOT THE MACHINE, CARRIED A STAGE FARTHER, REPLACE CHILD LABOR ENTIRELY?

In spite of its relatively low efficiency, child labor is used by many interests to as great an extent as the law allows. Its large supply and exceeding cheapness stand in the way of the fuller development of automatic machinery. Civilization pays the price in the resultant "debased coin" of physically and intellectually stunted and relatively incompetent industrial workers.

of child-labor conditions. Up to that time the children obliged to work in the mills had absolutely no protection against the brutality of the mill masters. Owen fixed the minimum age for employment in his mills at ten years—ridiculously low as we now look at it, but then a great step forward—and permitted those under twelve to work no more than six hours a day. Furthermore, certain educational qualifications were required of children precedent to employment in the mills, so that the schools were well patronized.

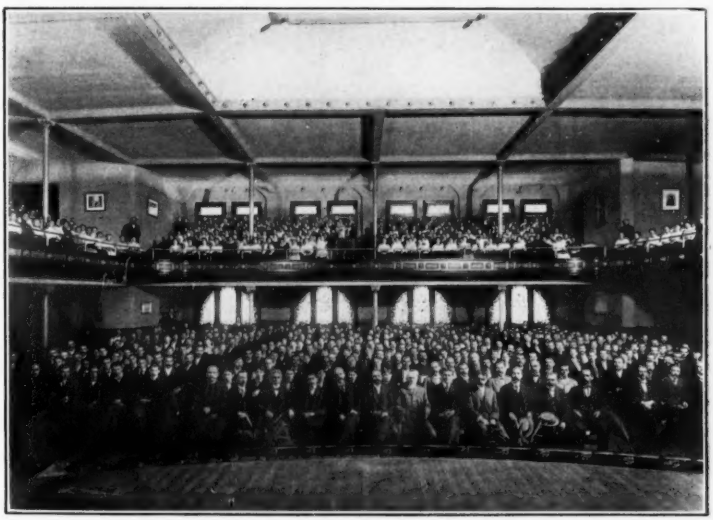
LIBRARY AND READING ROOM, FACTORY OF THE NATURAL FOOD CO., NIAGARA FALLS, N. Y.

In spite of difficulties and disagreements with more greedy and short-sighted partners, Owen's business conducted on such novel humanitarian lines succeeded amazingly and paid dividends much in excess of those previously realized; so that when he retired at the age of fifty-eight he was a very wealthy man.

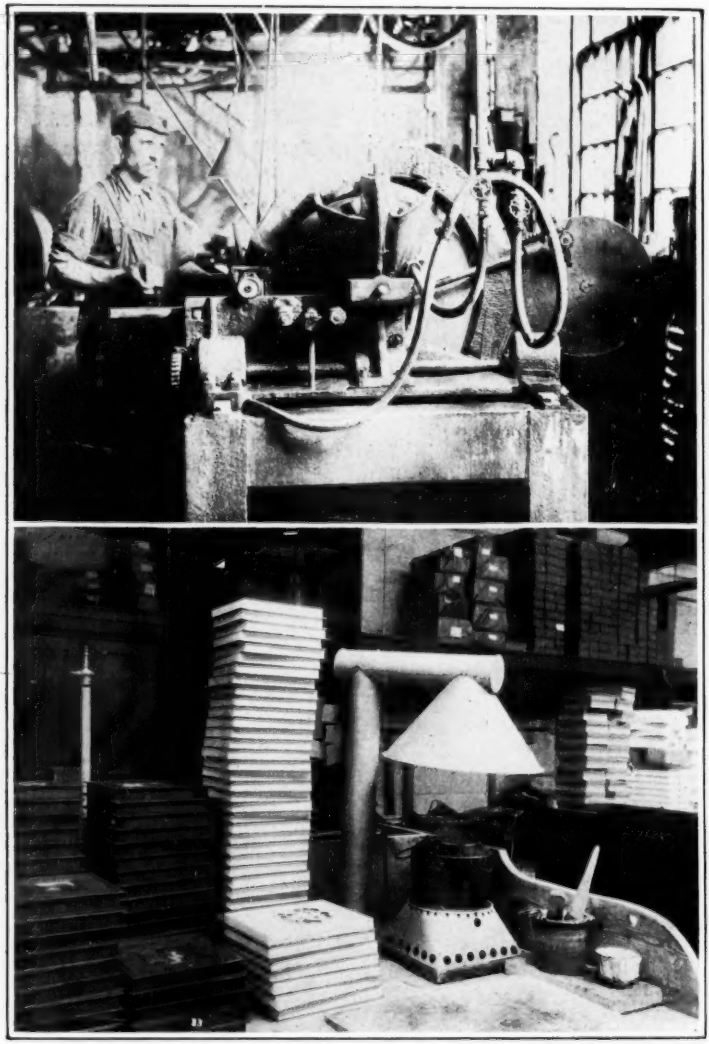
The New Lanark experiment attracted a great deal of attention, as many as two-thousand visitors from all parts of the world having been to see this "model town," as it came to be known, in a single year. The example of this pioneer altruist was not, however, largely imitated; and it was only through the enactment of restraining laws from time to time in response to the demands of outraged public opinion that mill owners generally came to have any serious regard for the welfare of their operatives. The securing of such a code of factory laws was a slow and difficult process. The opposition of "vested interests," the influence of selfish operators, frequently the indifference of the operatives themselves, made it hard to secure any laws for the correction of even the most atrocious of the abuses that had sprung up. The employment of little children in the mills is a case in point. This particularly inhuman abuse finally reached a stage where public opin-

ion intervened. Under the factory system the employees were always wretchedly poor and shiftless—almost necessarily so because of the conditions of wage and environment under which they worked. In consequence there were hordes of children that became charges upon the "rates" and were in the hands of the overseers of the poor. To reduce the public charges it became the custom to sell to mill owners for a period of years the services of these miserable little paupers. Often they were set at work long before they reached the age of ten, working, eating and sleeping in the same mill room. Some were found at work barely six years old and not tall enough to reach the working parts of the machines. They had been taught to get about on stilts. When tired, or sleepy, or weak, as was frequently the case because of the insufficient nourishment and the cruelly long hours—sometimes fifteen or sixteen a day—they were mercilessly flogged to their tasks. No wonder the child mortality was frightful. Even such revelations were alone insufficient to secure remedial legislation, and it required the active and unremitting efforts of men like Owen to induce Parliament to pass effective laws for the protection of operatives in the face of the opposition of the "vested interests."

There were, of course, notable exceptions among employers; and the abuses described were undoubtedly extreme cases. But there is

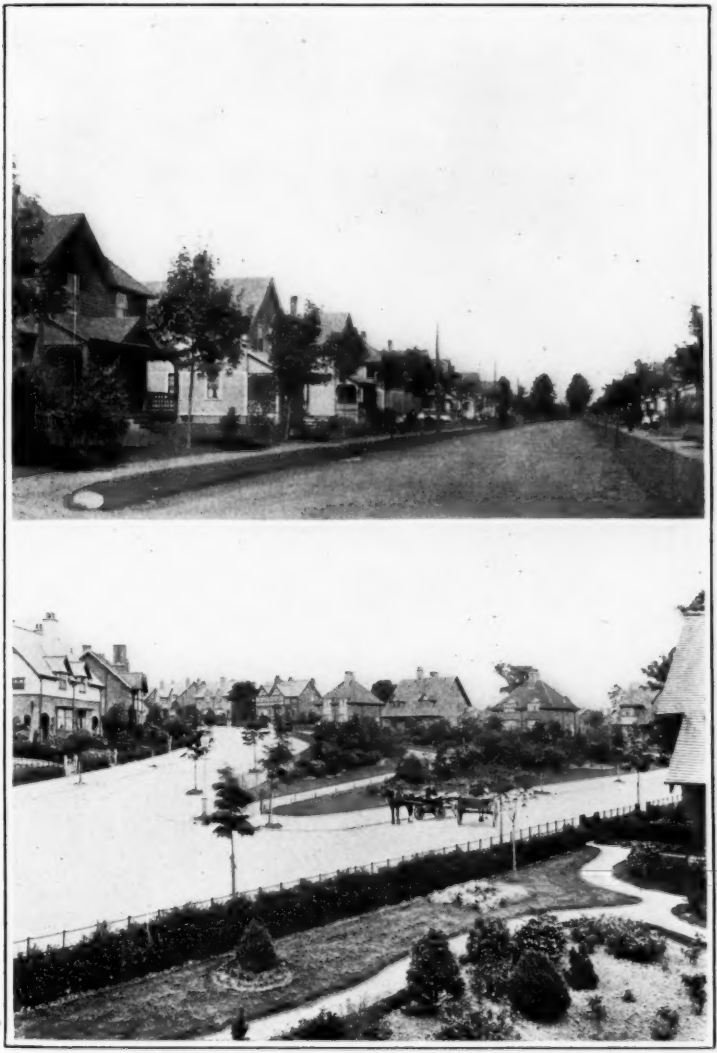


TYPICAL AUDIENCE OF FACTORY PEOPLE, AUDITORIUM OF THE H. J. HEINZ CO., PITTSBURG, PA.



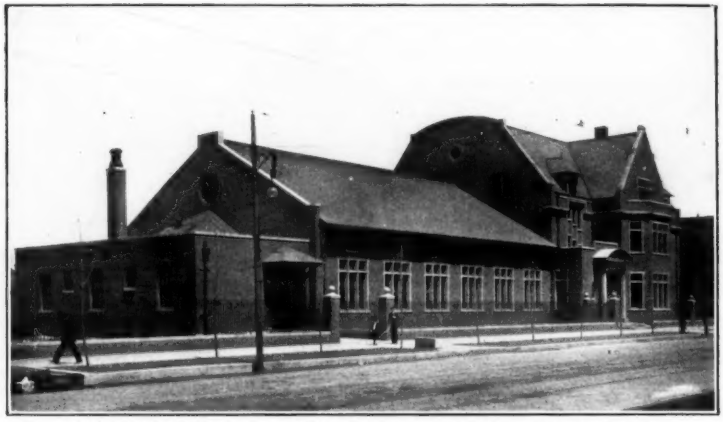
A CONTRAST OF CONDITIONS OBTAINABLE IN FACTORY OPERATIONS.

The upper view shows a disgraceful condition surrounding the wet grinding of small pieces, no effort being made to remove moisture and suspended particles of stone and steel, with which the air becomes filled. The lower picture illustrates a situation where almost equally offensive conditions might arise. The exhaust over the glue pot, and the cleanliness exacted in this paper-box shop, make the working environment hygienic as well as agreeable. This view is taken in the Cadbury Cocoa Works.



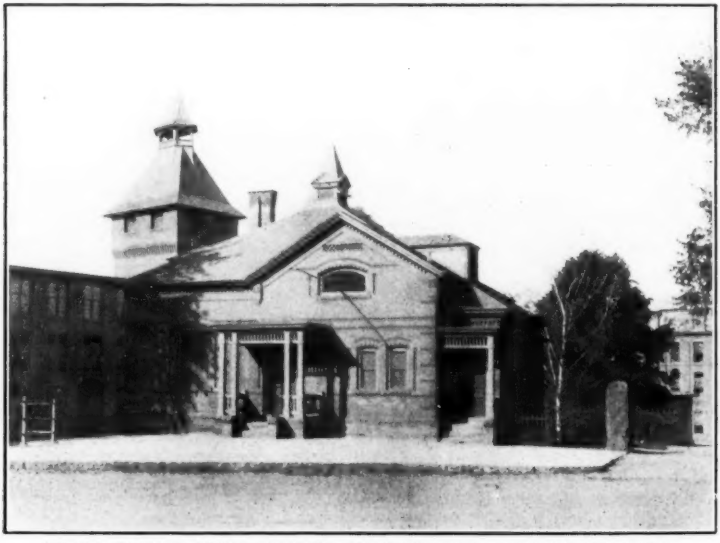
TWO EXAMPLES OF WHAT MAY BE DONE WITH EMPLOYEES' RESIDENCES.

Both illustrate the fruits of the policy of taking as much interest in the workpeople as in the machinery of the plant. The upper view is a street in Ludlow, Mass., showing the dwellings rented or sold to employees of the Ludlow Mfg. Associates. The lower scene is in Bourneville, England, where Messrs. Cadbury Bros. have partially solved the housing problem by taking the factory into the country, and leaving the worst features of city factory neighborhoods behind.



McCORMICK WORKS CLUB, INTERNATIONAL HARVESTER CO., CHICAGO.
Contains lunch room (convertible into an auditorium), baths, smoking and game rooms, lodge and society hall, and class rooms for evening classes.

nothing in the history of industry to indicate that, until recently, there has been any general disposition to recognize the moral obligation of employer to worker and to mitigate as far as possible the evils of the



AN OLD FACTORY OFFICE BUILDING CONVERTED INTO A SCHOOL FOR GIRLS.
Ludlow Manufacturing Associates, Ludlow, Mass. The building is the center of many of the social and educational interests of the female employees.

industrial system. That there is such a disposition at the present time is not open to doubt. The feeling is growing in the world of industry and trade that it is "good business" to treat the human part of the productive and distributive machinery humanely and even considerately; to provide employees with safe, decent, comfortable, and (so far as possible) agreeable surroundings, and with opportunities for recreation and intellectual development. How much the growing power of trades unionism and the unsettled condition of the labor market has to do with this feeling, and how much is due to an increasing sense of moral obligation, it is not to the present purpose to inquire. Apparently both are factors. The most important factor in the minds of many business men who are becoming interested in the subject is that it pays dividends. The thoughtful employer is finding that it is not merely philanthropy to do what he can to make his employees cheerful, happy and content; but that it is a paying investment, yielding tangible returns as well as intangible. One large manufacturer* has gone so far as to figure out in dollars and cents the gain resulting from certain improved conditions. Surely nothing could be more tangible than that. The same gentleman said recently, in summing up his experience: "One of the most profitable investments that can be made in a manufacturing plant is to give the largest possible advantages in the way of conveniences and sanitary arrangements. Every kind of legitimate comfort and convenience that may be provided for operatives is a source of profit to the employer, although apart from the moral obligation to care for the health and comfort of the employe." Another gentleman† doing a large business, who has within two or three years made a serious effort to get into close touch with his work people by giving them greatly improved conditions and surroundings, was asked the question, "Does it pay?" In reply he said, among other things: "Three years ago we had a standing advertisement for help wanted in every paper in the country, and then could not get enough. Today there are upwards of 100 applications on our waiting list. Last year, with 60 people less on our pay roll, we did a business of $20,000 more than the year before."

Of course the returns are not directly measurable. To be sure they ultimately show up in the balance sheet, but not always in recognizable items. They appear in a more happy and contented corps of workers, and in a consequently cheapened production by reason of the better quality and increased quantity of the output; in an absence of strikes and labor disturbances; in greater interest in the business; in an in-

* Mr. John H. Patterson, of the National Cash Register Co.

† Mr. S. W. Williams, of the Sherwin-Williams Paint Co.

creased personal loyalty; and in a dozen other ways, all tending to greater economy of operation in the establishment. The testimony on this point is indisputable, and amounts to this: However much it means in the sum total of civilization to have a community of cheerful, intelligent and virtuous operatives, it means a great deal more to the employer himself in the way of economic output and increased profits. That is to say, *it does pay.*

It is doubtless true that many, possibly even a large majority of employers, still look askance or with disfavor upon any attempt to introduce into business any features not immediately essential to its prosecution. To them "business is business" continues to be the prime axiom, with which "altruism" is irreconcilable; and they keep themselves in countenance with the reflection that all such schemes are paternalistic and therefore unacceptable to the working men themselves, as well as ethically unsound. In recent years, however, there have been so many experiments in applying altruism to business, and these so uniformly successful when attempted in a rational and moral spirit, that the practicability of sane "welfare" work among and for employees is not open to legitimate question. Indeed, it is beginning to look as if we were coming to the point where a business, in order to be continuously successful, will necessarily become thus moralized, whether the owner wishes it or not, because of the necessity for satisfactory conditions and environment as a means of retaining a desirable class of employees, such as are essential to effective competition. Such workers naturally prefer to perform their tasks under the most desirable conditions, and quietly drift out of those shops where there is evidently little thought for human beings, and into those other shops where the spirit of "the square deal" prevails.

The new industrial revolution has progressed far enough to assure workers of their power, and to point to the employer the folly of disregarding plain moral obligations toward them. There are still a great many employers who manage their businesses with the least possible consideration for the work people, who nevertheless declare themselves able to keep an adequate supply of labor; but it is a significant circumstance, to say the least, that it is this class of employers, almost exclusively, who are in more or less constant conflict with labor. From them too comes the cry that is just now so insistent for more efficient workers. *Efficiency in workers goes hand in hand with sanity in employers.*

AUTOMOBILE ENGINES CONSIDERED FROM THE OPERATIVE POINT OF VIEW.

By Rodolphe Mathot.

Mr. Mathot is widely known on the Continent, and indeed internationally, as one of the leading specialists in the design and construction of internal-combustion engines. In the study here presented he demonstrates the interesting and important points which have been definitely settled in practical experience with the larger machines but which many builders of the smaller units have overlooked or ignored, to their own serious disadvantage. —THE EDITORS.

THE latest automobile exhibit at Paris, and that which after a splendid success has just closed its doors at Brussels, have shown that so far as construction is concerned, one can no longer exactly speak of "bad" cars. The chassis as well as the engines, their transmission systems, and the accessories give proof of a veritable perfection in the manufacture and in the machining of the mechanical pieces.

Urged by the creating spirit, which has given such a strong impulse to automobile industry, these advances are due as much to the professional ability of our designers, as to the improvements which have been made in modern machine tools. Even metallurgy has found in the success of this mechanical industry a powerful stimulus, without which the absolute need of the manufacture of extra strong metals would not yet have manifested itself.

The systems of transmission seem to have been standardized, and aside from some exceptions, the chassis as well as the accessory parts tend toward fixed types.

But it is not the same with the engines, which, barring the vertical arrangement in front and the increase of the number of cylinders, seem to resist reduction to common rules as to form and principle. Designers seem in this respect to have thought more of making their engines run smoothly and regularly than of obtaining an economical output.

It may with reason be objected that the first named qualities are the most important ones in practice, and since the automobile is first of all an article of luxury, the question of economy can be of secondary importance only. But if this reasoning is correct when sport

alone is considered, it cannot hold good when the automobile is looked upon from the point of view of utility, that is, as a means of rapid locomotion for passengers, of transporting heavy loads or of making parcel deliveries in cities, etc. There indeed lies the future of the automobile industry; success must be sought along this line, because there lies the field in which the automobile will have the most applications and the most new openings.

Thus to safe and steady running must be added economical operation, two qualities which seem to be the attributes of the most noble if not the most useful conquest of man. I believe the moment has come when designers must turn their attention upon the engine, in order to make it a more rational machine—that is, one more in harmony with the great scientific laws which seem to have been too much neglected in the development of automobile engines.

Is not the industrial gas engine, whose power and vitality are manifested daily in a manner that is perhaps too much ignored by our automobile designers, an interesting "ancestor" of the automobile engine? It is therefore well to remind them that alongside of the marvelous little engine which they have so skilfully applied to the new method of locomotion, there has developed a giant—the great gas engine, which has acquired the right to be mentioned concurrently with the old steam engines of our workshops, iron factories, etc., where it is represented by units of 100, 1,000, and even 3,000 horse power. One construction company has produced in four years about one hundred gas engines, representing a total of more than 100,000 horse power, which means an average of 1,000 horse power per unit. These large machines are fed either with poor gas which is produced in the plant itself in special gas producers, or with gas from blast-furnaces, coke ovens, etc.

Their gigantic aspect and their striking outlines hardly remind one of our little, graceful automobile engines, although they have the same essential parts.

In short, if in the lapse of not quite five years nearly 400,000 horse power have been turned out in the form of powerful gas engines, it must be recognized that this is the fruit of almost forty years of long research and scientific study. All resources of pure and applied science were put to work. The laws of physics, the principles of chemistry, and the rules of mechanics, were brought to the aid of the scientific workers who have long since addressed themselves to the complex question of the internal-combustion engine. Nevertheless it was only by long stages that we reached the point at which we are arrived

today—that is, at what may be termed a solution which is industrially satisfactory.

But our younger designers of high-speed engines ignore, or forget too easily, the dawn of the great discovery to which they have contributed but a small share in the form of the automobile engine. And it is for want of having followed more closely the genesis of the industrial engine, its evolution and development, that they often neglect to derive instruction from it. Therefore, it often happens that we see introduced into automobile engines certain designs and arrangements—sometimes new and sometimes highly elaborated—which have already been rejected or abandoned in the construction of industrial engines as being bad in practice or defective in theory. In order to avoid this we would wish that the designers of our interesting little motors might seek inspiration more freely in what has been done in the large engines. This suggests the following points to which consideration might well be given:—

1.—The shape of the cylinder heads or combustion chambers.

2.—The shape of the pistons.

3.—The method of distribution, the valves, etc.

Shape of Cylinder Heads.—The shape of the cylinder head of an explosive motor plays a part whose considerable importance is too often ignored or overlooked.

Internal-combustion motors are first of all thermal engines which transform into mechanical work the heat given off by the motive fluid. Considering that for every 100 thermal units produced in the engine by the combustion of the exploding mixture, 25 to 30 units only are transformed into useful work, the importance of making heroic attempts to recover the 70-75 per cent of heat lost will be recognized. Of the latter about 30 per cent are absorbed by the cooling water, which should maintain the cylinder at a temperature consistent with the necessity of oiling; 40-45 per cent are carried off by the products of combustion escaping into the atmosphere at high temperatures. All that could be regained from the heat lost by cooling, radiation, and discharge would raise the efficiency of the engine. Let us see how this can be effected.

The interchange of temperature between the fluid which acts in the cylinder and the cylinder walls depends upon several items:

1.—The surface and nature of the cylinder walls.

2.—The difference in temperature between the gases of combustion and those walls.

3.—The duration of their contact.

1.—Among the materials (all more or less good conductors of heat) employed in the manufacture of the engines or their head ends, the choice is practically limited to cast-iron and steel. There is then nothing to be gained here, whereas so far as concerns the surface of the cylinder-walls in contact with the hot gases large savings may be effected. The essential conditions would be that the head ends should present, with the largest possible volume, a minimum of interior surface.

The volume of the cylinder head depends on the compression, and cannot surpass 1/3 to 1/5 of the total volume of the cylinder; because the resulting temperatures, with high compressions, would be such as to produce premature explosions. As the capacity of the explosion chamber is fixed, the means of reducing the interior surface must be found in the form. The shape giving a minimum of interior surface would be a hemisphere. The bottom of the piston in the outer dead-center position will constitute the base of this geometrical volume. Also, to reduce to a minimum the cooling surface which it offers, it must be plane and not round.

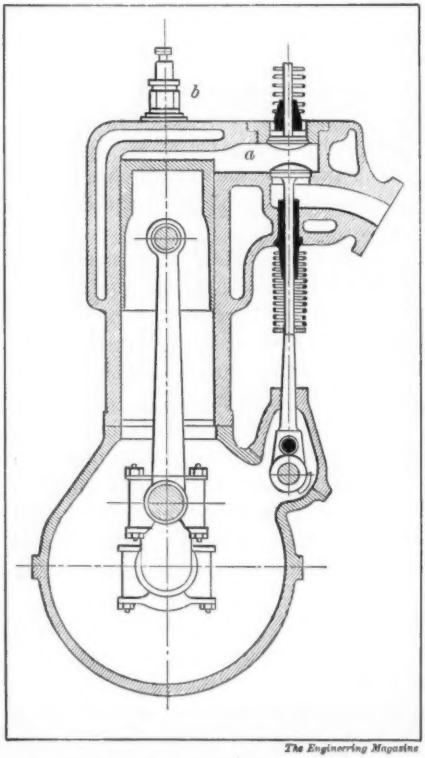
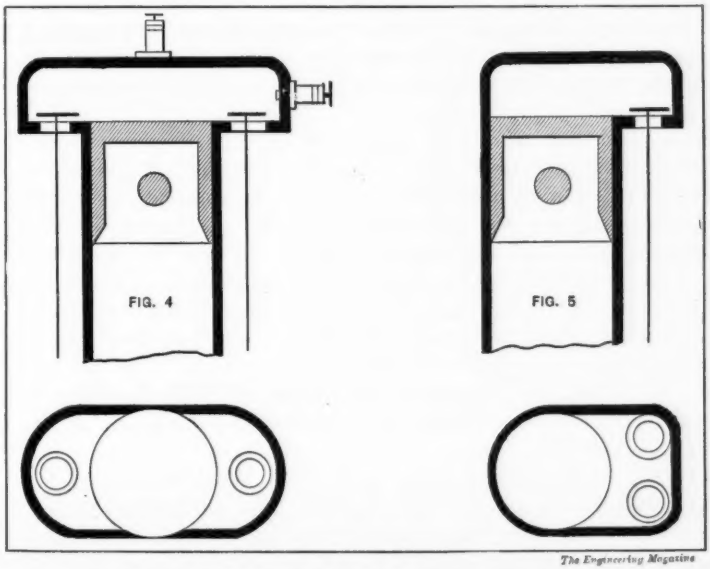


FIG. I. DE DION TYPE CYLINDER AND VALVES.

The necessity of saving a favorable space for the valves and for their manipulation constitutes, it is true, an obstacle to the construction of explosion chambers like the ones just advocated. We will review the more or less complex forms which designers have been led to give to the head ends on account of mechanical reasons.

The most ancient and most widely accepted form is the De Dion engine, which constitutes a classical type having the free gas-inlet valve mounted above and in the same axis as the exit valve. (Figure 1). The explosion chamber is formed by the extension of the cylinder and by the recess in which the valves operate. Of the various forms of cylinder heads that we shall consider, it is perhaps the one which from a morphological point of view is the least in contradiction to the principles enunciated. The sort of antechamber formed by the lateral part produces, it is true, an additional surface in contact with the gases; but on account of the position of the inlet valve, the fresh gas bathes the outlet valve at each admission, this being most favorable to the cooling of the latter. The portion of the flame or ignition contrivance in (a) or still better in (b) assures a constant "washing" of the electrical contacts, by the gas charges. Also the products of combustion are expelled as thoroughly as possible after each explosion, thanks to the favorable form of this head end.

The positively operated inlet valve gave rise to a different type derived from the first Figure 4). This type of head end has the valves placed opposite to each other in two symmetrical positions.



FIGS. 4 AND 5. HEAD ENDS WITH POSITIVELY OPERATED VALVES.

The ignition contacts are placed either in the admission space or in the bottom of the cylinder head. In this case the cooling surface is certainly carried to a point most harmful to the output. Furthermore, if this form has the merit of symmetry and as a consequence of interchangeability of the valves, it is evident that as regards the expulsion of the products of combustion, it cannot be very satisfactory. It offers to a part of the gases at the time of exhausting a lodging place in the admission space where they remain confined until they mix with the charge of fresh gas. Their presence contaminates and decreases the volume admitted to the cylinders.

It will be seen also that this form of complex head end is less favorable to the propagation of the flame, because the gases run, during combustion, uselessly against the angles and crevices which such a head end presents, this being detrimental to the realization of a maximum force on the piston. From the mechanical point of view this effect can be compared to that which the explosion of a charge of powder would have on the projectile of a cannon if that charge were in a breech located at the side and not in line with the axis, rather than exploding directly behind the projectile. In practice the projectile and the powder charge are to the cannon what the piston and the gas compressed in the head end are to the engine.

From a physical point of view, that is considering the velocity of propagation of the flame in the exploding mixture, I will venture to state once more this perhaps trivial comparison, which however fixes the ideas well.

The exploding mixture, a vapor each particle of which is surrounded by air, may perhaps be compared to a package of gun-cotton made up of a porous mass having each fibre surrounded by air and therefore forming a very powerful combustible. Supposing that the package of gun-cotton had a form similar to the space in which the gas is compressed, and that it be ignited at one extremity (a); it can be imagined that combustion will be the less rapid and less complete in a given time the more tortuous the path over which the flame has to travel in order to attain all the parts to be consumed. On the contrary, the burning or propagation of the flame will be the more rapid, the more compact the package of gun-cotton and the nearer to its center it is lighted.

This is absolutely what occurs with the exploding mixture in the head end of the engine. In this respect the head end having the two valves next to each other in one chamber (Figure 5) will be perhaps less unfavorable, because a more homogeneous and more compact mix-

ture can be formed in an enclosure presenting less cooling surface.

Hence to approach the ideal theoretical conditions it would be necessary to make a hemispherical head end or explosion chamber, as was mentioned at the beginning of this paper. But this form cannot be obtained perfectly on account of the placing of the valves. A lucky attempt has, however, been made in this line by the firm Pipe, who have manufactured an engine in which the two valves have their valve stems converging toward the center of the cylinder head (Figure 6).

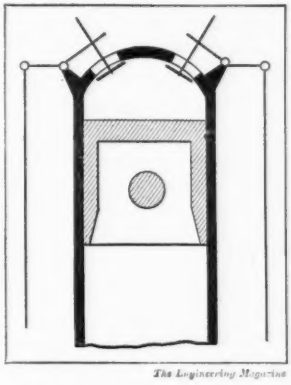


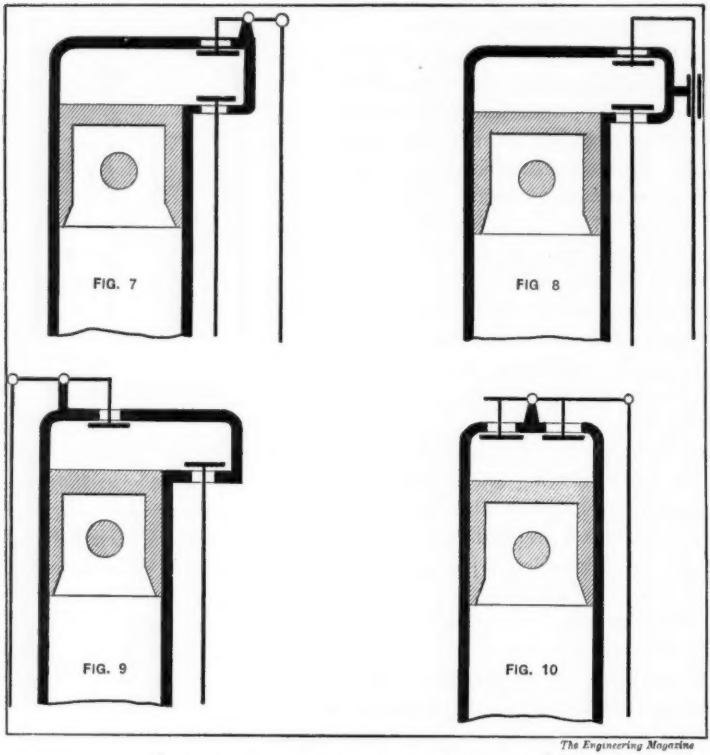
FIG. 6. HEAD END WITH RADIALLY DISPOSED VALVES.

To have a perfect arrangement, it ought to be possible to make the valve-disks flush, so that there would not be any projecting nor retreating parts in the cylinder. As far as operation goes, the mechanism and the proper proportions of the valves are also a preponderating element. An inlet or exhaust valve furnishing an insufficient passage to admit or exhaust the gases would cause a harmful resistance to admission or exhausting.

The inlet valve, if it is automatic—that is to say, held on its seat by a spring—will present a large area, and produce a sufficient passage by a small rise. It will therefore lift easily as soon as it is made to do so by the vacuum which the piston produces behind it during the admission stroke. As the inertia of the valve might diminish the free play of its spring, this valve should be as light as possible and the spring must have the minimum tension sufficient to bring the valve rapidly to its seat the minute the period of admission is over.

The automatic valve opens when the piston is sufficiently displaced to produce a strong enough suction. Hence the valve will give passage to the gas only when the stroke of the piston has commenced. In the same way the valve is brought back onto its seat by the spring before the suction stroke is completed. Therefore a whole cylinder full of gas is not introduced.

Theoretically, the valve ought to open as soon as the stroke begins, and close only at the end of the stroke, in order to fill the cylinder completely with the gas drawn in. This result is partially obtained by the mechanically operated admission valve, the opening and closing of which is regulated mechanically and depends on the position of the



FIGS. 7, 8, 9, 10. VARIOUS MODES OF ARRANGING INLET VALVES.

piston. I say "partially," because the necessity of creating a relative vacuum in the cylinder to draw the air in and to accomplish its carburation, evidently prevents us from filling it with gas at atmospheric pressure. Such a condition would be realized only if the gas entered the cylinder under pressure, as is approximately the case with engines working with city gas. From this must be deduced that the mechanically operated inlet valve is not the ideal, and that it does not considerably increase the useful work of automobile engines. It has at any rate the undeniable advantage of making the running of them more elastic, and especially of letting them run regularly at slower speeds.

The regulating of the inlet valves can however be done in a great variety of ways. Some methods are shown diagramatically in Figures 7, 8, 9 and 10.

A good number of reputable designers consider that the advantages of the mechanically controlled valve do not compensate for its mechanical complication, and they stand by the well proportioned automatic valve. Others have adopted the mean of both methods by using a mechanical arrangement by which the valve is lifted from its seat at the precise instant at which suction commences. After all, this arrangement has the complications of the mechanically controlled valve without giving all the advantages.

Governing.—Governing the speed—that is to say, the number of revolutions of the engine as regards to the work which it has to do—was obtained some years ago by means of what is termed "throttling the exhaust." To effect this a centrifugal or inertia governor severed the connection between the exhaust valve and its controlling valve-rod as soon as the engine surpassed a pre-determined speed limit. This valve then remained closed during the course of several consecutive cycles, in which the piston, instead of sucking in fresh gas, only expanded and compressed the products of combustion that had remained in the cylinder. As soon as the speed had decreased sufficiently for want of moving impulses, the governor ceased to act, the connection between the exhaust valve and its controller re-established itself, and the explosions again succeeded each other. This method of governing consisted therefore in momentarily stopping the explosions. It presented the inconvenience of making the engine work by jerks.

For this has been substituted the regulation called "by admission," which consists, for engines with free valves, of making the governor act on a butterfly valve or a sort of slide valve which throttles the gas passage more or less, and is inserted in the gas-inlet pipe, between the carburettor and the engine. In this fashion the gas flow is regulated and depends on the speed at which the engine runs. The explosions are thus produced without interruption, but they vary in intensity, according as the governor admits charges of greater or less density. This process is more economical and strains the engine less because the jerks are suppressed.

It has been still further improved in engines supplied with mechanically operated inlet valves, by arranging the controlling contrivance so that the moment and duration of the stroke of the inlet valves is varied by means of the governor, and so more or less gas is admitted and the quantity regulated according to the number of revolutions.

As nothing positive exists on the subject of regulation, many de-

signers (and among them not the least competent) have renounced the use of a governor pure and simple and replaced this automatic apparatus by an arrangement worked either by hand or by foot.

It must be observed that if the governor is indispensable in industrial engines, which run at constant speed and which must maintain it of themselves, it is hardly so with automobile engines, whose speed varies immensely and which are never left to themselves.

Exhausting.—We have examined the part played by the admission and the conditions which must be realized. Let us examine the exhaust, in which the details of operation have not less importance.

It is to be remarked that the exhaust valve is exposed to particularly high temperatures, especially during discharge, because then it is literally bathed in the inflamed gases which escape from the cylinder. It cools only when in contact with its seat, which is moreover very narrow and with which it is in contact only during the three consecutive parts of the cycle—namely, suction, compression, and explosion. Therefore the seat must be abundantly cooled by water circulation, and the jacket in which the water circulates should surround it equally well on all sides.

Whatever the form of the engine, the cooling water should enter the jacket in the neighborhood of the seat in order to cool it more thoroughly.

The valve proper must have a sufficient stroke to present a large outlet to the burning exhaust gases, first because if these were "throttled" a sort of rolling between the walls of the valve disk and the seat would occur; the gases would not fail to raise the temperature and to deform both of them; secondly because all resistance to the exhausting of the gases is harmful to the efficiency of the engine.

Resistance to exhausting produces a back-pressure, which absorbs useful work (to the detriment of the engine), behind the piston at the moment of its return motion—that is to say, during the time when it ought to be entirely free. This resistance must therefore be fought by all possible means.

Independently of the effect of the rolling of the valve there exist several causes of back pressure which we may examine.

The insufficient size of the section or the exaggerated length of the exhaust pipes is one of the first causes; to point out the defect is to indicate the remedy. Therefore pipes should have at their origin a section at least equal to that of the exhaust valve, and this should be increased as soon as the arrangement of the parts of the engine located in the immediate neighborhood will permit it.

The mufflers which terminate the exhaust pipe, with a view of deadening noise, should be mounted as near as possible to the engine.

In engines of more than one cylinder, the form of the collecting tube which receives the discharges at the exhausts of the different cylinders must be judiciously determined, so that each cylinder is provided with its proper exhaust pipe leading to the common muffler.

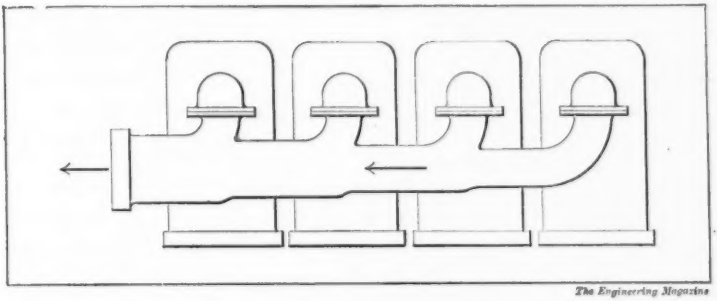


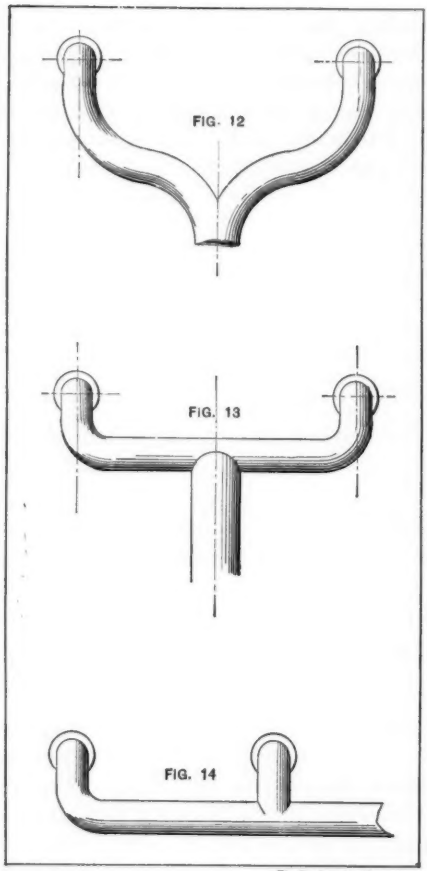
FIG. 11. EXHAUST TUBE SUCCESSIVELY ENLARGED IN SECTION AS THE EXHAUST FROM EACH ADDITIONAL CYLINDER ENTERS.

The section of this collector tube must increase as the different exhaust tubes branch into it. (Figure 11.) These branchings should be made of such profile that the gases can readily be expelled (Figure 12), because if they were made perpendicular to the exit, the gases thrown with a high velocity against the walls of the collector would form eddies that would hinder expulsion (Figures 13 and 14).

As the products of combustion leave the cylinder they occupy an excessive volume on account of their high temperatures. If instead of having a temperature of 600 to 800 degrees, they could be lowered to a temperature of about 100 degrees, their volume could be reduced more than one-half and a pipe section one-half less would suffice to expel the same quantity. It would therefore be of evident interest to cool the exhaust.

Some designers have understood this very well. They have placed cast-iron radiator rings or disks on the collector tube, which have the effect of increasing its cooling surface. It would be necessary to improve on this and to extend the water circulation to one part of the collector the same as it is extended on one part of the exhaust tube at the place where it comes out of the cylinder.

In large industrial motors we return moreover to the use of a positive water circulation around the lower part of the exhaust pipe, which serves as much to cool the gases as to prevent the excess of



FIGS. 12, 13, 14. CORRECT AND INCORRECT PROFILES FOR EXHAUST PIPE CONNECTIONS.

heat which the pipe would release into the engine room.

In spite of the precautions that may be taken to fight the resistance to the exhausting of the products of combustion, the use of the muffler unfortunately annihilates them in part.

This discharge pot (or as the chauffeur calls it, the "muffler") serves to deaden the noise of the exhaust. But this deadening is obtained only to the detriment of the free emission of the exhaust gases. The noise is muffled by making the gases pass through chambers and recesses arranged in the muffler. Also, the more that the noise has been deadened, the more can it be said that harm has been done to the power of the engine. It is therefore to the disadvantage of the high efficiency of the engine that the chauffeur gives to the public this legitimate satisfaction, which consists in not deafening it by the sonorous puffing of his machine.

Use efficient mufflers, then, in the city and in inhabitated places, but dispose of them by one turn of the hand when in the country and in the plain where you will harm no one.

Crank Shafts.—The question of crank shafts increases in importance with the increase of the number of cylinders. The working

of a single-cylinder engine would be very unsatisfactory if the crank were not balanced by placing counterweights on the cheek plate or on the disks which take the place of the crank arm, in order to compensate the weight of the crank and part of the moving connecting rod. As concerning the two-throw crank of two-cylinder engines, it is well to rectify at this opportunity a very widespread error, which consists in considering the crank as in equilibrium itself.

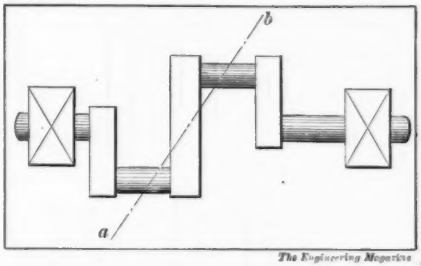


FIG. 15. SHOWING AXIS OF ROTATION SOUGHT BY REVOLVING TWO-CRANK SHAFT.

It is quite true that it is in equilibrium in the static condition—that is to say, as it is tried by the workshop methods, which consist in balancing it on knife edges and regulating it in such a manner that it remains stationary in all positions; but it is never so in the dynamic state—that is to say, when in motion. As a matter of fact, in these conditions the two cranks tend to straighten up and try to place themselves in an axis of rotation (a b) passing through their centers of gravity (Figure 15).

A similar phenomenon shows itself in a more conspicuous manner in the grindstones of the miller, for instance. It is known that the upper one of these stones rotates about a vertical axis passing through its center. Now it may happen that the stone will have holes on the surface finished for the grinding. These holes are filled with a special cement, which is very compact and which the miller uses for these repairs (Figure 16). But this cement acting like a counterweight will bring the stone out of equilibrium and make it hang to one side at (a). Equilibrium may be reestablished by pouring in lead at the part diametrically opposite (b) but in spite of the equilibrium thus established it will be soon noticed by the work that the stone wears off at

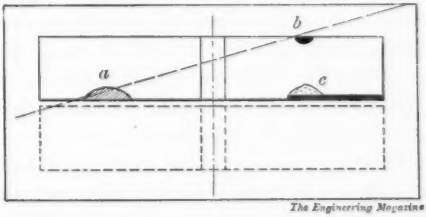
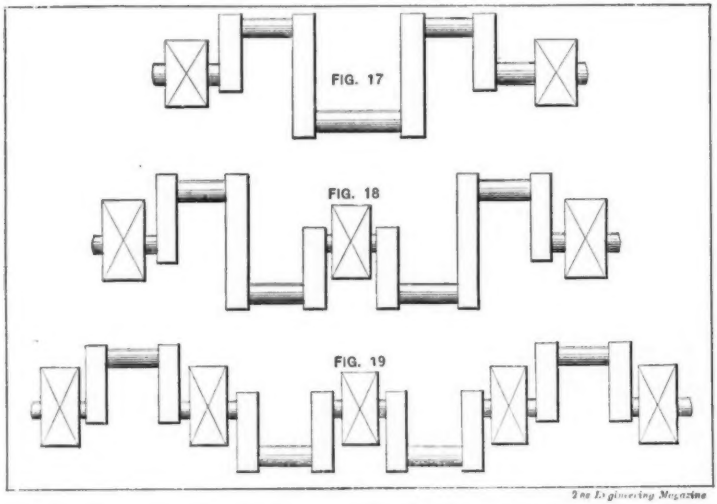


FIG. 16. EFFECTS OF COUNTERBALANCE ON AXIS OF ROTATION OF A MILLSTONE.



FIGS. 17, 18, 19. VARIOUS METHODS OF DISPOSING THE JOURNALS OF THREE-CRANK AND FOUR-CRANK SHAFTS.

(c), which goes to show its tendency to lean some more to that side. In reality the stone seeks to turn according to its centrifugal force, that is in a plane (a b) which tends to become perpendicular to the axis of rotation.

To put the stone in dynamic equilibrium the mass of lead would have to be poured in at (c).

This case is comparable to that of a double-throw crank, and shows that for equilibrium of the latter, each crank must be counterbalanced by a weight placed at the opposite end of the crank arm.

There is no reason to observe the same precautions for the crank shafts of a four-cylinder engine. Formerly they were constructed with three cranks, the two connecting-rods of the central cylinders being attached to the middle crank (Figure 17). To support properly the shaft (which had journals at the extremities only) a quadruple crank with inside journals is now made (Figure 18). With a view to solidity, certain designers have even placed each crank between two bearings, so that there were five bearings to the shaft (Figure 19). Here we have perhaps an excess of precaution. In this case there is an increase of bearing friction, which is more serious in my opinion than the vague eventualities of breakage of the shaft.

AN ELECTRIC POWER PLANT IN THE WEST INDIES.

By Percival Robert Moses.

While THE ENGINEERING MAGAZINE does not generally publish papers relating to the installation of specific equipments, it has seemed in this case that a complete summary of the problem presented, its solution, the installation of the equipment, and the operation after completion, would be of interest, particularly as the work had to be carried out in a newly developing country under conditions differing from those existing at home.

THE problem presented by the power plant described in the following pages was somewhat complex: A sugar mill was to be erected in a West India Island, and electric power was to be supplied to the mill for operating a quantity of machinery; but this was not to be the main work of the plant. The country around this particular mill was arid and irrigation necessary. Water for irrigation was to be obtained from driven wells grouped together at various points, 60 or 100 to a group; the maximum distance from the sugar mill to the farthest group of wells being approximately 7 miles. Besides the power for irrigation and power for the sugar mill, it was also necessary to provide lighting for a small village and for the mill.

The property was situated on a deep-water bay, and the mill was to be located close to the shore. Coal cost in the neighborhood of $7 a ton delivered. There were several ways of solving the problem, and the first matter to be settled was whether it was better to use a central station close to the sugar mill, and to distribute power for pumping electrically, or to install separate steam pumping plants at each group of wells, and a separate electric plant for the sugar mill proper. A central station located close to the sugar mill was decided upon, with electric-driven pumps at each group of wells, because estimates showed that the cost of pumping, using separate steam pumps, including the cost of separate labor force at each pumping station, was more than double the cost of using the central station; the relative and estimated costs being $59,000 with compound condensing pumps as compared with $26,000 using electric-driven pumps. The estimated and initial cost of the electric transmission plan was about $50,000 more than with the separate plants.

The various types of electric pumps were considered, and the rotary pump having lobed impellers was determined upon as the best. The reasons for this choice were that water for irrigation had to be pumped against heads varying from 80 to 200 feet; this put the centrifugal pump out of the running on account of its comparatively low efficiency against high heads; the triplex pump was abandoned on account of its lack of simplicitv and the danger of scoring and wearing of pistons and cylinders through sand being drawn up from the wells. The rotary pumps purchased had a guaranteed efficiency of 80 per cent; that is to say, 80 per cent of the power delivered to the motor was to be shown in the water pumped; and they were further guaranteed to draw from anything up to 30 feet. This was accomplished by keeping the clearance of the impellers very small. This type of pump lends itself very readily to electric drive.

To take care of the various electrical requirements in the best manner, three voltages and currents were chosen. For electric pumping for irrigation, 6,600-volts, three-phase, alternating-current system was adopted, this voltage being generated directly at the dynamos, carried out on the line, and transformed down to 220 volts before entering the motors at each pumping station.

For lighting the village and surrounding district, alternating current at 240 volts on the three-wire system was used in order to reduce the cost of wiring.

For factory power and lighting, electricity was supplied at 120 volts, direct-current; this voltage and current being chosen in preference to the 240-volt direct-current system for the reasons stated in a previous article (THE ENGINEERING MAGAZINE, September, 1904). The direct-current system was chosen in preference to the alternating-current system for the reasons stated in the same article, viz., the lower first cost, and advantages in speed control and crane work.

It was decided to run the plant condensing, using salt water from the bay, on account of the high cost of coal, and the fact that the sugar mill would not only be able to supply its own steam, we were informed, from the bagasse or refuse sugar cane, but would also have surplus steam to supply to the power plant; hence the exhaust steam from the electric engines could not be used. High cost of coal also made it imperative to save in every way, so a Green fuel economizer was installed, and a compound high-efficiency air pump and circulating pump used. As the water for boiler purposes was not of a good quality, it seemed bettter to install a surface condenser, saving the condensed water and returning it to the boilers. To do

this, a special arrangement for gettting rid of the oil was necessary, consisting of a baffle-plate grease separator in the exhaust line draining to a tank with equalizing pipe and surface blow from the tank, hand-operated, arranged to blow off oil at frequent intervals. No trouble whatever has been experienced from oil in the three years of the plant's operation, and the system is one that should be of value in every condensing plant where the feed water is expensive or of poor quality.

It was also decided not to let one general contract, but to make individual contracts with all the manufacturers of apparatus; to employ erecting men directly, and to erect the work ourselves; this being evidently the most economical method of handling such equipment. Thirty separate contracts were made, the largest being the electrical contract, including all the electric apparatus, except line material and some motors; and the smallest, intercommunicating telephone system amounting to $170. The contracts included: power house, boilers, engines, dynamos, rotary converters for delivering direct current to the sugar mill, induction motors for pumping stations, transformers, air and circulating pump, eleven miles line material, poles; boiler-feed pumps, steam auxiliary apparatus, such as heaters and separators, eight rotary pumps varying from 1,000,000 to 4,000,000 gallons per day capacity, smoke stack 5 feet diameter by 150 feet high, auxiliary steam piping, two small kerosene engines, and a quantity of small material.

The complete equipment as planned and installed consisted of three boilers with space for a fourth, which has since been installed, two compound condensing engines belted to 6,600-volt, three-phase dynamos, two rotary converters arranged to be driven either electrically by alternating current, or by belt from a non-condensing steam engine. The usual auxiliary apparatus installed included feed-water heater, feed-water filter, economizer, grease extractor, surface condenser, etc. The power house was built of steel with galvanized-iron sides and roof, the floor of the engine room being kept 5 feet above the ground, the boiler-room floor being level with the ground.

With this combination of rotaries and alternating-current dynamos, the three electrical systems can be obtained. When irrigation is required, which is for eight or nine months of the year, the large alternating-current dynamos and the high-efficiency engines are run supplying the pumping stations directly, and the factory mill indirectly through the rotary transformers. At slack seasons, when the irrigation plant is not in operation, the rotaries can be run as

dynamos directly from the small engine and all three forms of current can be obtained from them, the same as from the large alternating-current dynamos, except that the small quantity of high-voltage alternating current which may be needed for irrigation, and the lower-voltage alternating current for lighting, are obtained indirectly through transformers, and the mill requirements are supplied directly from the direct-current side of the rotary transformer. In order to avoid trouble with rotaries, the 25-cycle three-phase alternating current was used, and this has no bad effect on the lighting, as there are no arc lights.

The full plant as completed has a capacity of 1,000 boiler horse power with a maximum continuous operating capacity of 850 kilowatts.

Some figures on the cost per horse power or kilowatt f. o. b. New York will be of interest in this connection, as the prices have not changed materially:

Boilers	$14.00	per horse power
These are a special type with steel sides suitably insulated, chosen on account of the trouble of getting competent masons.		
Compound condensing engines	$17.00	per horse power
Alternating-current dynamos	15.00	" kilowatt
Rotary converters	25.00	" "
Induction motors	22.00	" horse power
Transformers	16.00	" kilowatt
Air and circulating pump and condenser	7.00	" horse power
Line material	375.00	" mile
This is exclusive of poles, which cost about $350 per mile additional. The poles had to be sent down from the United States and were treated with creosote to preserve them.		
Boiler-feed pumps, feed-water heater, and other steam auxiliary apparatus, including piping	6.00	per horse power
Smoke stack, about	2.50	" " "
Economizer	2.50	" " "
Switchboard, exclusive of boards in pumping stations	4.00	" kilowatt
Rotary pumps, about $500 per million-gallons capacity, exclusive of motors, or inclusive of motors, about $1,000 per million gallons capacity.		
Power house, exclusive of common labor and freight, $23 per kilowatt capacity.		
This was high on account of the short delivery required, the ordinary delivery costing about $20 per kilowatt.		

The plans and specification covered standard apparatus somewhat modified to meet the conditions of a semi-tropical climate; this applies more particularly to the condenser and to the electrical machinery, the allowable rise in temperature of the electrical machinery being reduced to 35 degrees C; and the condenser surface increased to provide for warm condensing water. The plans had to be somewhat more accurate than the usual plan made out for bids,

as all the piping had to be cut to measure and sent down ready for erection. As the steam pressure carried was to be 150 pounds, the steam piping was all made up with flanged joints, the pipe being first screwed into the flanged edge of the pipe, peened against the edge of the flange, and the whole placed in a lathe and the face of the flange trued up; flanges were made male and female, with copper gaskets, and no trouble has been experienced with leaks.

All the apparatus was inspected before shipment, and this is very necessary where material is to be sent a long distance. It is impossible to test large engines before shipment, but the process of manufacture and the completed product should be carefully inspected. All the large electric companies have very complete methods of testing, and the usual runs were made. The pumps were tested to determine capacity and inspected to see that the material and workmanship was proper, and were run under conditions as nearly as possible approximating those under which they would operate after erection. Most of the other apparatus was merely inspected before shipment, no test being possible, except such hydrostatic tests as are made on boilers, cylindrical tanks, and other similar apparatus.

The material was shipped as it became ready, power house first, boilers next, engines next, and then dynamos and all the electrical apparatus. The equipment was not fully completed until about a year after placing the contracts. There were a great many difficulties in the way of erection and shipments were slow. It was not possible to obtain competent boiler erectors, steamfitters, wiremen or other mechanics on the island, and all the skilled labor was sent down from the United States; common labor was all supplied on the ground. The usual rate of pay for common labor was 40 cents a day, and it was worth about this amount. The natives worked 12 hours and would walk from 5 to 10 miles each direction morning and night to and from work, before the railroad was built; but they would not carry more than a very small quantity of material, and when they did work, worked slowly and without intelligence. They would also, as soon as they had made a few days' pay, stop work and not show up for two or three days more. Gradually, by increasing the pay and picking the men, a proper gang of helpers for line work and other work was obtained. Besides sending down laborers, it was necessary to send down also all tools, as practically nothing could be purchased within a radius of 50 miles. What this means can hardly be appreciated by the man who has been accustomed to sending out to the nearest supply store for a wrench or a washer or anything else

LOG BLANK Monday

May 29th 1905 DATE

TIME	AMPERES GEN. No. 1	AMPERES GEN. No. 2	AMPERES GEN. No. 3	OUTGOING LINE VOLTS	OUTGOING LINE AMPS No. 1	OUTGOING LINE AMPS No. 2	OUTGOING LINE AMPS No. 3	Exciter No. 1 VOLTS	Exciter No. 1 AMPS	Exciter No. 2 VOLTS	Exciter No. 2 AMPS	ROTARY No. 1 A.C. AMPS	ROTARY No. 1 AMPS FIELD	ROTARY No. 1 D.C. VOLTS	ROTARY No. 1 D.C. AMPS	ROTARY No. 2 A.C. AMPS	ROTARY No. 2 AMPS FIELD	ROTARY No. 2 D.C. VOLTS	ROTARY No. 2 D.C. AMPS	STEAM PLANT TEMPERATURE F.W.	STEAM PLANT TEMPERATURE Comp.W.	STEAM PRESSURE HIGH	STEAM PRESSURE REC.	STEAM PRESSURE COND.
6[00] A.M.	13.5	13.5		6600	27	27	27	119	60			4.	7.5	127	280							142	10	24
7 "	13.5	13.5		6600	27	27	27	118	45			3.5	7	128	210							145	10	24
8 "	13.5	13.5		6600	27	27	27	118	45			3.5	7.	128	210							144	10	24
9 "	13.5	13.5		6600	27	27	27	118	45			3.5	7.	128	210							145	10	24
10 "	13.5	13.5		6600	27	27	27	118	45			3.5	7	128	210							142	10	24
11 "	13.5	13.5		6600	27	27	27	118	45			3.5	7	128	210							145	10	24
12 N.	13.5	13.5		6600	27	27	27	118	45			3.5	7	128	210							146	10	23.5
1 P.M.	13.5	13.5		6600	27	27	27	118	45							3	6.6	128	210			140	10	23.4
2 "	13.5	13.5		6600	27	27	27	118	45							3	6.6	128	230			140	10	23.
3 "	13.5	13.5		6600	27	27	27	118	45							3	6.6	128	230			144	10	23.
4 "	13.5	13.5		6600	27	27	27	118	45							3	6.6	128	230			145	10	23.3
5 "	13.5	10		6600	20	20	20	118	37							3	6.6	128	230			146	9	23.6
6 "	11	11		6600	27	27	27	119	57							2.3	5.6	130	160			150	11	24
7 "	11	11		6600	27	27	27	120	64							2.3	5.6	128	160			140	11	24.
8 "	16.5	16.5		6600	33	33	33	120	64							3.6	5.4	128	230			150	12	23
9 "	16.5	16.5		6600	33	33	33	120	87							3.4	5.6	126	280			150	12	23
10 "	16	16		6600	32	32	32	120	87							3.	6	128	260			150	12	23
11 "	16	16		6600	32	32	32	120	87							2.7	6.1	126	260			150	12	23
12 "	16.5	16.5		6600	33	33	33	120	87							7.8	6.7	129	270			148	10	23
1 A.M.	16	16		6600	32	32	32	120	87							3.6	6.	127	240			150	12	23
2 "	16	16		6600	32	32	32	120	87							3.7	6	126	300			150	12	23
3 "	16	16		6600	32	32	32	120	87							3.9	6.7	127	280			145	12	23
4 "	16	16		6600	32	32	32	120	87							3.4	6.7	126	240			150	12	23
5 "	16	16		6600	32	32	32	120	87							3.5	6.4	127	300			150	12	23

REMARKS

Grover House lighting supplied by Exciter
House & Office lighting and lighting on 1st & 2nd floors of Factory, supplied by 40 K.W. Transformers.

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EXAMPLE OF DAILY LOG BLANK, AS FILLED OUT IN SERVICE.

that he may want. Heavy rains made the roads impassable, wagons sinking up to their hubs in the mud, and no labor was obtainable nor work possible during these times. The rainy season is short, lasting only a few months, but when it does come, the whole country becomes a floating mass of mud, making transportation of heavy machinery impossible. A statement showing the distribution of labor on the different parts of the work, and the condition of erection was forwarded weekly, on regular blanks itemizing the chief individual features of the work, and requiring only brief manuscript entries. As comparatively few of the blanks were necessary, they were prepared by manifolding a type-written form. These reports were supplemented by a letter and by requisitions for supplies.

Shortly after the commencement of the work of erection, a hotel was completed in which the men from the States could find room to sleep and in which meals were served. There was a great deal of difficulty in getting proper provisions, and everything had to be imported, as not even milk or butter was obtainable, and a few of the men became dissatisfied with the conditions and left; but in general there was but little trouble on this score, and none from disease.

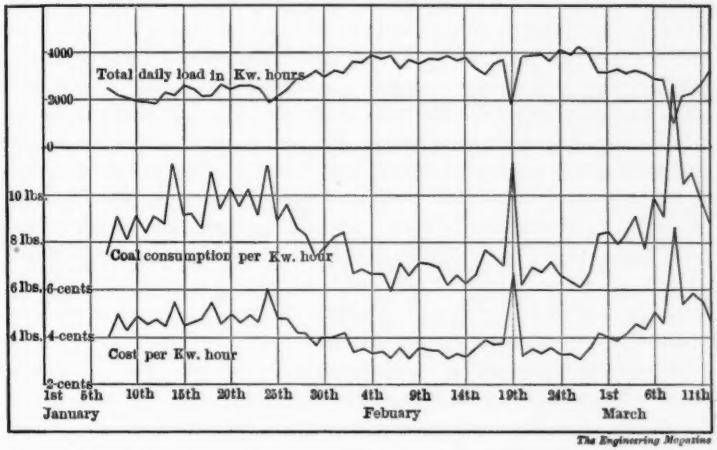
The chief trouble experienced with the men from the States was drunkenness, and it is of the highest importance in choosing men to send out on such work where they are away from control, to be sure that they do not drink to excess. In order to get such men it is necessary to pay good wages, as they can make good money at home. The wages paid on this work varied from $200 a month for the head man to $150 and $125 a month for his assistants, and from $110 to $125 a month for first-class linemen and steam fitters. In all cases the traveling expenses were paid, and the men drew pay from the time of leaving the States. Their traveling expenses were also paid going back, provided they had given satisfaction and remained until the work was completed. They were given lodging, but paid for their board at $4 or $5 a week. If they were discharged for incompetency or drunkenness, or if they left without being discharged, they did not receive any traveling expenses home. After completion of the erection the force was re-organized as follows:

1 Chief Engineer
2 Assistant Engineers
2 Electricians
4 Oilers
3 Firemen
3 Assistant Firemen
Servant
Telephone Boy
7 Peons for transporting fuel.

May 22nd 1905 DATE

WATT METERS		SUPPLIES USED				EMPLOYEES' TIME					OPERATION OF MACHINES		
OUTGOING LINE			Quant.	RATE	COST		ARR	DEPT	ARR	DEPT	MACHINE	START	STOP
PRESENT READING	218545	Coal	38 [illegible]	[illegible]	[illegible]	Chief Engineer	6a.m.	6 p.m.	6 p.m.	6a.m.	Boiler No 1	Yesterday	
PREVIOUS	211465	Wood				1st Assistant			6a	6a	" No 2		
DIFFERENCE	7080	Cyl. Oil	1 gal	.31	.31	2nd "	6a	6a			" No 3	noon	12a
KILOWATT HOURS	7080	Eng. Oil	1½ gal	.30	.45	3rd "					" No 4	Yesterday	2a p.m.
FACTORY LINE		Lamps				Oiler No 1	6a	6a			Engine No 1		
PRESENT READING	476220	Packing				" No 2	6a	6a			" No 2	Running	
PREVIOUS	475440	Sundries			.89	" No 3			6a	6a	" No 3	Running	
DIFFERENCE	780	Rep. Engines				" No 4			6a	6a	" No 4		
KILOWATT HOUR	780	" Dynamos				Electrician					Rotary No 1	Running	12a noon
KILOWATT HOURS (not		" Pumps				1st Assistant			6a	6a	" No 2	noon 12a	Running
to be deducted from induction meter)		" Boilers				2nd "	6a	6a			Exciter No 1		Running
KILOWATT HOURS		" Condenser				Fireman No 1	6 p.m. 2a	11a			" No 2	a.m	6 p.m.
Calculated P. F.		" Green Econ.				" No 2	a.m		10a	7a	Ice Machine	6a	6a
		Wages			17.78	" No 3	6a	3a			Machine Shop	6a	5a
		Salaries			11.70	Asst. " No 1	6 p.m. 2a	11a			Carpenter	6a	5a
		Trans. Fuel			3.00	" " No 2	a.m		10a	7a	Sta. A		Running
						" " No 3	6a	3a			" B		
											Pump C		7a p.m. Running
											" D		
TOTAL K. W. HOURS	7080	Total cost			11.80						" E	Running	5 45 p.m.
SUPPLIES RECEIVED		SUPPLIES REQUIRED				NOTES					" F		7a p.m. Running
1 Bar soap	.07					Temp. at 6 P. M. 88° F					" G	Running	4a p.m.
12 lb waste @ 06 per lb	.72					Kind of Day Cloudy					" H		5a p.m. Running
	.79					Kind of Fuel Soft Coal					" I		
						Quantity of Fuel 19.405 tons					" J		
											" K		Running
											" L		Running
											Old Tredouble		Running

EXAMPLE OF SUMMARY SHEET, COVERING FUEL, LABOR, SUPPLIES, AND OPERATION.



PART OF THE LOAD, FUEL-CONSUMPTION, AND TOTAL-COST CURVE.

All the men, except the chief engineer, his assistants, and electricians, were natives, and received from 25 cents a day for telephone boy to $1.20 a day for the better men. This force includes the day and night force, the plant running 24 hours a day.

In order to keep track of the operating expenses and results, a complete system of log blanks and reports was made up, samples of which are shown on pages 574 and 576. One set of logs shows the hourly supply of current and steam pressures, while the other shows the total quantity of electricity manufactured, its cost, times of arrival and departure of the force, and times of starting and stopping of the machinery, including the pumping stations; also notes as to supplies received and required, and temperatures, kind of fuel, etc. These results are plotted into a curve showing the cost per kilowatt hour for different total quantities of kilowatt hours. The minimum cost per kilowatt hour is 1.53 cents; the average cost about 2.5 cents; minimum coal per kilowatt hour is 4.4 pounds. During regular operation of the plant the maximum coal per kilowatt hour runs to as high as 12 pounds. These figures are for loads varying from 2,000 kilowatt hours per day to 7,000 kilowatt hours a day, or from one-third full load to full load.

The supply of steam from the sugar house has also been obtained, as originally intended, which further decreases the cost. This cost is at least 50 per cent greater than the cost would be in a similar

plant in the States, as the coal costs about twice as much and the labor is more expensive as more of it has to be used. The coal cost forms nearly 35 per cent of the total operating cost. These costs do not include fixed charges on the investment, which add about 1½ cents per kilowatt, or a total cost of about 4 cents per kilowatt hour.

In estimating the fixed charges, the same rates that govern in the States have not been used, but an interest rate of 7 per cent, and a depreciation rate of 6 per cent, have been allowed, while the rates in the States should not be over 5 per cent in each case. These same rates were used in deciding originally as to the proper expenditure allowable for the increased efficiency, and no extra money was paid for increased efficiency in the apparatus, unless the increase showed at least 15 per cent on the investment.

The total efficiency of transmission from steam cylinders of the engines to the gear of the pumps is 54 per cent. The efficiencies of the various pieces of apparatus are about as follows:

Generators, full load 92 per cent; three-quarter load 90.5 per cent; half load 87 per cent.

Transformers, full load 97 per cent; three-quarter load 97 per cent; half load 96.5 per cent.

Pump Motors, full load 89 per cent; ¾ load 89 per cent; ½ load 87 per cent.

Pumps, full load 80 per cent; ¾ load 75 per cent; ½ load 75 per cent.

Rotaries, full load 91½ per cent; ¾ load 90 per cent; ½ load 85 per cent.

Transmission line, about 5 per cent loss at full load.

On this basis, the engines using 18 pounds of steam per horse-power hour at ¾ load, and 8 pounds steam evaporated per pound of coal, the coal per horse power of water pumped amounts to 4.1 pounds.

Very little trouble has been experienced with the operation of the plant, and the repairs have been normal. The total operating expense is within 10 per cent of that originally estimated, so that the economy of the electric transmission over the individual steam plants originally estimated may be taken as approximately correct.

EDITORIAL COMMENT

WHILE the country waits for the report of the Advisory Board on the Isthmian Canal, Congress is giving an interesting demonstration of the essential unfitness of a republican Government to carry out large works of construction. Four hundred minds, trained in engineering, and organized under a master in the profession, driving steadily toward one well-conceived, economic plan, would be an ideal force for successful achievement. But four hundred minds chiefly ignorant of the requirements and limitations of engineering work, and each inspired with a sense of independent sovereignty; an energetic minority of them merely obstructive, and the sympathetic majority almost at blows among themselves over irreconcilable differences of policy; the whole body moving stiffly and tardily, by a series of concessions toward a course of compromises—surely, no institution could be conceived less fitted to act with the promptness, the energy, the specialized knowledge, and the clear judgment necessary for the "economical direction of the sources of power in Nature for the benefit of mankind." The significant modification of Tredgold's definition, by the way, is Mr. Wallace's.

In brief, constructive enterprise is not one of the normal functions of the Government. It never has been happy in that field, as almost any one even of its minor undertakings will witness. The opportnnities for disappointment in the case of the Panama Canal are large in proportion to the difficulty of the work involved. It seems to be growing increasingly clear that while the magnitude and the surrounding conditions of the case manifestly indicated a Governmental acceptance of the task of "piercing the Isthmus," the functions of the Government should be only to see that the work is "well and truly" done—not actually and physically to do it. Here, as elsewhere, let the Government govern, wisely and honestly, as belongs to its sphere; and let practical constructors build, economically and effectively, as belongs to theirs. We believe that an adequate contracting organization, of the necessary high standards of moral and financial integrity, under the most searching Government supervision and in the highest light of publicity, will put through the construction with the utmost attainable economy of time and cost, and with a fraction only of the likelihood of scandal and bitterness of feeling involved in adherence to the method of direct Government execution. Such a contracting organization would justly command the services and the faith of the best engineering talent in the country. Under similar corporations, some of the highest engineering standings have been won, and no man would hesitate to trust his future or his character into such hands. Under direct political or departmental management, it has already been painfully proven that the most priceless possession of the engineer—his high professional reputation—is not safe.

* * *

AT the recent meeting of the American Society of Mechanical Engineers, in New York City, it was demonstrated, if any demonstration was necessary, that one good topical discussion is worth a dozen papers, both in respect of the valuable information elicited and in view of its success in

interesting the members in each other's work. The discussion upon the subject of "bearings" will not only form, when completed, the best collection of information upon this important machine element available, but it will doubtless lead future committees on meetings to endeavor to select similar stimulating topics for coming occasions.

In this connection it may not be amiss to consider the extent to which the material provided for discussion affects the success of any such gathering of professional and technical men. Some papers are very properly prepared and presented as matters of record, and include valuable data and results of researches which might otherwise remain unpublished and unavailable. Other contributions, fortunately growing fewer in number, and less obvious in nature, are intended to give publicity to the interests of individuals. But there are still other papers which should be most welcome as to contents and are of real value to the meetings at which they are presented, but which might be made still more valuable if they were prepared in a slightly different manner.

Papers for record may sometimes be presented by title, without involving any great loss to the members, absent or present, since their usefulness exists in their availability for reference. The great value of most papers, however, lies in their effect in interesting members to discuss the salient points, and thus to add, from record and memory the results of varied experience.

A paper should make those to whom it is addressed "sit up and take notice," and to do this it should be put into such form that its full purport is appreciated from the first, the salient features being brought out with due proportion, and the conclusions emphasized with full weight. As a successful playright once said with regard to the presentation of a telling incident to an audience "First you must tell them that it is coming, then impress them as powerfully as possible that it is occurring, and finally explain to them that it has happened." All scientific men are not playwrights, and perhaps this is just as well ; but in a great number of instances excellent technical papers have been presented and passed by without discussion, simply because the form was such that the full purport could not be generally grasped by such casual examination as most men feel able to give.

* * *

Now that the plans for the new building for the United Engineering Societies have been published and distributed to the membership of the three National societies, it may be of interest to note some of the salient features of the structure which, in about a year, is expected to be ready for occupancy. Probably no building of similar character has been the subject of so much careful study by those who are to occupy it, and to the original plans of the architects there has been added the benefit of the experience of a number of eminent men in various branches of the engineering profession.

The result is a building of most effective external appearance, containing a great auditorium especially designed for professional sessions, and yet affording in the immediate proximity ample facilities for social intercourse. With this are associated suites of modern business offices for purposes of administration, as well as a number of smaller halls for gatherings of various numbers, and these halls are all provided with equipment equal to that of a modern university. Above all are placed the quarters for what will doubtless become the greatest scientific library in the country, including rooms for private research and investigation, for indexing and collaboration, and for special library work. The book stack is ample for future growth, and the whole arrangement is that for a library intended for active service for men who know how to use it.

REVIEW OF
THE ENGINEERING PRESS.
"THE WORLD IS ITS FIELD"

THE GAS-TURBINE PROBLEM.

A CONSIDERATION OF THE PRACTICABILITY OF OPERATING TURBO-MACHINES BY THE DIRECT UTILISATION OF THE GASES OF CONTROLLED COMBUSTION.

Dugald Clerk—Junior Institution of Engineers.

WE have already reviewed in these pages the accounts which have been made public concerning the successful experiments in the operation of a gas turbine in Paris by Messrs. Armengaud and Lemale, while among the important contributions to this question we may be permitted to mention the papers of Dr. Lucke and Professor Reeve in the leading pages of recent issues of this magazine. The latest study of the subject of the gas turbine is found in the address of Mr. Dugald Clerk, upon assuming the office of President of the Junior Institution of Engineers, from which we make some abstracts.

"In most of the recent discussions upon gas-turbine problems, it has been recognized that the temperatures possible in the cylinder gas-engine are impossible for the gas-turbine. It has been fully proved by many investigators that the temperature quite common in ordinary gas-engine practice ranges as high as 2,000° C., though in the best practice, for most economical results, 1,500° C. or 1,600° C. appears to be an upper limit. With these temperatures, a first-class modern gas-engine of about 50 horse power will give an indicated efficiency of 35 per cent. At the same time, the negative work of the cycle is so low that the mechanical efficiency of the engine may be as high as 86 per cent., or even more. If one realizes what the temperature of 2,000° C. means, it becomes very evident that no turbine constructed either on the lines of Parsons or Laval could possibly be made to work with continuous supply of such gases; as 2,000° C. is considerably above the melting-point of platinum. It is much higher than the temperature at which cast-iron flows from the crucible, or, indeed, the temperature of the interior of the blast-furnace. Any blades of iron, steel, or, in fact, of any other material, even firebrick itself, become fluid or semi-fluid at the temperature. It is obviously hopeless, therefore, to attempt in the gas-turbine temperatures which are quite feasible in the cylinder-engine. This fact is generally recognized. It is accordingly said, by those who take a favorable view of the gas-turbine, that it is necessary to supply the turbine with gases at a mucn lower temperature. Mr. Neilson fixes the temperature of 700° C. as one which steel turbine blades would probably stand without too rapid deterioration. I fear that on this point I must differ from him, because, in my experience, oxidation of steel (and even iron) is a fairly rapid process at this temperature. Nothing new has been proposed as to the thermo-dynamic cycle of the gas-turbine; so that all reasoning upon efficiencies depends upon the deductions already made from internal combustion engine practice.

"Seeing the impossibility of constructing a turbine with materials to stand a high temperature, many have proposed to convert high temperature into kinetic energy, so that instead of having work stored up in the gas in the form of heat, the heat shall disappear, and the energy of the heat be transformed into motion of the gaseous par-

ticles at a high velocity. Such proposals, then, include the compressing of a gaseous mixture to (say) 50 lbs. or 60 lbs. above atmosphere; the igniting of that mixture within a combustion chamber at constant pressure; and the expansion of the mixture through an expanding jet of the Laval type so as to drop the temperature and obtain its equivalent in kinetic energy or velocity of the gaseous particles. The rapidly moving particles at the relatively low pressure and temperature are then allowed to impinge upon rapidly rotating blades of sickle configuration; and they are supposed to give up their energy of motion on the blades, and so expend work upon the turbine."

The cycle of operations involved in a gas turbine of the kind considered by Mr. Clerk requires a rotary compressor of high relative efficiency to supply the air to the fuel and deliver the products of combustion to the nozzle. A nozzle is then necessary, of such design as to insure a free expansion which shall be quantitatively equivalent to adiabatic expansion behind a piston. The discharge from the nozzle must then be delivered upon a rotating turbine of such construction as will secure the transformation of the kinetic energy of the moving gases into effective work with a high degree of efficiency.

"Assuming air to be the working fluid, and the specific heat to be constant through the temperature range, it is easy to calculate the efficiency of the Joule or Brayton cycle, that these operations in effect represent. It would be useless to attempt to work a turbine at a pressure so low as to be relatively inefficient compared with the gas-engine, so I have chosen a Joule cycle of (say) 48 per cent. ideal efficiency, which in a cylinder gas-engine would probably give in practice about 30 per cent. indicated efficiency. For this ideal efficiency the pressure of compression would require to be 141 lbs. per square inch absolute. To give power with a reasonably small pump, I shall assume a maximum temperature of 1,700° C.—that is, assuming a perfect compressor and a perfect nozzle expander, the temperature would only fall from 1,700° C. to 750° C. Plainly, this temperature would be too high for a Laval disc with blades. In order to get a reasonable temperature on expansion, it would be necessary to assume a maximum temperature in the combustion chamber no higher than 1,000° C.; and this would bring down the temperature after complete expansion to about 500° C., which, no doubt, steel turbine blades can be expected to stand for some considerable time.

"With these assumptions, however, the gas-turbine would not be very economical as compared with cylinder engines, even assuming all difficulties overcome. The theoretical and practical difficulties, however, are very serious indeed. To begin with the question of an efficient air-compressor. I am not aware of any turbine compressor capable of compressing up to 140 pounds absolute from atmosphere with anything like 60 per cent. efficiency. Before success could be attained, this efficiency of compression (so far as diagram is concerned) should be at least 90 per cent. in order to allow for unavoidable mechanical and other losses in the subsequent processes. It has, it is true, been proposed to substitute cylinder compressors operated from the turbine, instead of turbine compressors; but this, it appears to me, would be equivalent to abandoning at once all the advantages of the turbine principle. If reciprocating cylinders are to be used for compressing, there is no objection to using them also for expanding."

Mr. Clerk has serious doubts as to the practicability of obtaining the temperature drop with an expanding nozzle in a manner to that existing behind a piston in a cylinder, and in this point he is largely sustained by the experiments of Dr. Lucke. Assuming, however, that adiabatic expansion can be secured by extreme care in design and construction, the problem of the conversion of the motion into work remains to be solved. Even the best steam turbines do not attain as high an efficiency as the best piston engines, it being found impossible to adjust the velocity of the blades to suit the varying velocity of the steam; and this difficulty becomes still more serious with the gas turbine. Assuming efficiencies of 90 per cent. each for the compressor and nozzle and 80 per cent. for the conversion in the turbine, Mr. Clerk computes that the best efficiency to be expected for the whole machine will not be

above 22 per cent., somewhat lower than is now attained by well designed gas engines.

So far as the mechanical difficulties are concerned, Mr. Clerk admits that these may be minimised by the use of the so-called mixed turbine, in which steam and gas together are discharged upon the wheel, but he believes that this would result in a still further efficiency. It is this process which is advocated by Professor Reeve, and which has already been put into practice by Armengaud and Lemale, and it certainly appears to be more promising than the dry gas turbine. There is no doubt that questions of mechanical design and construction enter into the problem to almost as great an extent as those of thermodynamic theory, but it is not impossible that the constructive difficulties may be overcome.

The desirability of the successful solution of the gas turbine problem is not to be based altogether upon the single element of thermal efficiency, since such matters as convenience of application and smoothness of motion are also of much importance. The present internal-combustion motors, operating upon the Beau-de-Rochas cycle have the great disadvantage of furnishing only one power stroke in every four, this demanding heavy fly wheels and special regulators to insure a steady and smooth motion upon the shaft. The possession of a small, high-power, high-speed rotary combustion engine would be found a great advantage for motor cars, for aerial navigation, and for numerous uses which are now obliged to use the reciprocating four-cycle motors, and the mechanical advantages of the turbine might well be found to compensate for a slight loss in thermal efficiency. The gas-turbine problem offers many difficulties, but these have not yet been demonstrated to be impossible of solution, and the inducements are undoubtedly sufficient to cause many to continue their efforts to achieve success.

THE FIRE RISK IN THEATRE BUILDINGS.

AN ENGINEER'S OPINION CONCERNING THE DEFECTIVE CONDITION OF FIRE PROTECTION IN MODERN THEATRE BUILDINGS.

John R. Freeman—American Society of Mechanical Engineers.

IT is a custom, and a most admirable one, in the American Society of Mechanical Engineers, that the presidential address, instead of consisting of a mass of generalities upon the broad field of the work of the engineer, shall be based upon that department of engineering work with which the speaker himself has been closely identified. As a consequence, the transactions of the society are annually enriched by monographs upon important departments of engineering, forming records of ripe experience in practical fields in which success has been achieved. At the recent meeting the retiring president, Mr. John R. Freeman, spoke upon one branch of the subject in which he is a recognized authority, that of fire prevention and fire protection, calling attention to the great defects which exist in modern theatre buildings as regards fire risk, and suggesting the importance of giving proper engineering supervision to such structures.

Mr. Freeman compares the present status of fire protection in theatre buildings with that existing in manufacturing establishments, most unfavorably as regards the former class of structures, and we quote some of his remarks in this respect at length.

"It is a fair and moderate statement that fire protection as applied to theatres and buildings of public congregation is from ten to twenty years behind the fire protection of large industrial works, and true that the fire hazard to theatre property in general, as measured by insurance rates, is ten times as great for the modern theatre as for the modern factory. All of this is unnecessary. The safeguards needed are mostly simple; the main features of some of them are already worked out in the great factories, and the additional safeguards required to be worked out or adjusted for this special case are the automatic smoke vents, the safe proscenium curtain, the safe warming and ventilation and the proper arrangement of automatic sprinklers on stage and in dressing rooms and storerooms. In the factories of New

England chiefly there are the most advanced methods of fire prevention anywhere to be found.

"In the course of my own studies of the theatre and auditorium problem I have seen almost everywhere conditions affecting the safety of life that would not be tolerated for a moment by the managers of our best industrial works. For example, I have seen in one of the best New York theatres the wedge shaped space beneath the sloping floor of the auditorium used as a storeroom for trunks and properties. This room was also the plenum chamber for the ventilation. Suppose that any cause should start even a slow smouldering fire in this room; the smoke rising through the air ducts in the floor might throw the audience into a panic and cause great loss of life. In one of the most famous halls in America I found the portable wooden flooring used to transform the main seating space into a ballroom, stored in a dark passageway which formed the main air chamber between the heating coils and the concert hall, all thus kiln dried to perfection, and when I showed it to the manager and to an intelligent aldermanic committee and urged its immediate removal they saw no danger and thought me hypercritical and could not even see that automatic sprinklers would be of use in such a concealed storage space. In Chicago, within a few months after the appalling disaster at the Iroquois Theatre, the aldermen rescinded the rule calling for automatic sprinklers over the stages and rigging lofts of the theatres because the managers believed they wouldn't do any good and might start a panic should one happen to open prematurely. Every factory manager or mill engineer will admit the absurdity of such a statement. In Boston the law still accepts the non-automatic sprinkler pipe, to be opened by hand, a device which has now been generally discarded in factory fire protection, in favor of the automatic. Most important of all, I have found behind the scenes and in the mechanics' rooms a lack of the scrupulous neatness and order that characterizes a modern well organized factory, have found a multitude of dark, concealed spaces used as catch alls and an apparent lack of appreciation by owner and architect that a flood of daylight in storerooms, workrooms and dressings rooms is the best of safeguards by making dirt, disorder and dangerous rubbish conspicuous."

Mr. Freeman described the study which he had made of the fire at the Iroquois theatre, in Chicago, in which such a great loss of life occurred, referring also to the disastrous fire at the Ring theatre, in Vienna, the fire at the Brooklyn theatre, and others, and showed that the sequence of events was practically the same in all such disasters. In practically every instance the following events took place:

"A stage crowded with scenery.

"The sudden spread of the flames over this scenery.

"The opening of a door in the rear of the stage, an inrush of air.

"Scant smoke vents over the stage, an outburst of smoke under the proscenium arch.

"Death to those in the galleries.

"The obvious suggestion might be: Make the scenery incombustible; but the efficient fireproofing of scenery, so that it will not all burn up if a fire once gets well started on the stage, simply appears to be impracticable.

"The ordinary construction with a high, spacious chamber for the hanging loft above the level of the proscenium arch makes it a simple matter structurally to keep this fire and smoke out of the auditorium, and no matter how great the mass of flaming scenery a smoke vent of one-eighth or one-tenth the area of the stage, if instantly opened, would probably prevent suffocation. The conditions are similar to those of a fireplace. The high space over the stage screened by the arch is adapted to give the best of chimney draft. An ordinary rule is to make the throat of the chimney at least one-tenth the area of the fireplace opening, or the space through the damper one-eighth the area of the hearth, and when we simply provide an adequate chimney area and a damper that will surely open we shall have adopted a safeguard that would have saved four-fifths of those who perished at the Iroquois, regardless of defective curtain, defective exits and absence of fire hose on the stage."

The first precaution for the control of fires in theatres is the provision of a sufficient opening or vent for the smoke and

flame above the stage. Mr. Freeman showed that the requirements of city ordinances in this respect are generally evaded, partly because of the desire to prevent draughts of cold air upon the stage, and to avoid inconveniences from leaks in rainy weather. Mr. Freeman described several designs of ventilators which would obviate these inconveniences, and at the same time provide a full and effective opening in time of fire, these including movable shutters which are opened automatically by the parting of fusible links. The fundamental requirements of such events are as follows:

"Absolute certainty of opening by force of gravity, in spite of neglect, rust, dirt, frost, snow or expansion by heat, twisting or warping of the framework, quickness of opening to be secured by automatic links of the thinnest metal practicable and also by controlling the doors by a cord run down to the prompter's stand and to the station of the stage fire-guard; the operative mechanism of the smoke vent should be simple and massive; it should be of such form that it can be tested daily or at least at the weekly inspection by partially opening it, preferably closing it again by means of the cord running to the prompter's stand. It may add to its safety if it can be used whenever needed for the ordinary ventilation of the stage, thereby keeping it under constant notice."

After the proper venting of the stage, the second safeguard to be provided, in the opinion of Mr. Freeman, is the complete equipment of the stage and other parts of the building with automatic sprinklers, the auditorium alone being excepted. There appears to be no reason for believing that such sprinklers as have proved themselves effective in mill buildings would not also act in a satisfactory manner in theatres, and open with sufficient promptness to be of material service.

The third safeguard is the curtain which closes the opening of the proscenium arch. In nearly all theatres this protection is attempted to be furnished by the use of a curtain consisting of a heavy canvas woven of asbestos fibre. There are several materials answering to the name of asbestos, and care should be taken to ascertain that the fibre used contains no chemically combined water, since this is readily given off under the application of heat, rendering the material liable to crumble and break to pieces. Experiments made by Mr. Freeman have shown that ordinary asbestos curtains give but little protection, being difficult to guide, and liable to be forced out into the auditorium by the pressure of the expanding air and gases behind. The steel curtains required in Chicago are better, but these are rarely provided with proper guides, and unless fitted with metal guides capable of holding them firmly, while permitting smooth and rapid lowering, they are not effective, but when properly fitted they should be serviceable.

"In safeguarding our factories against fire, we find systematic inspections and the filing of a weekly report one of the very best means toward safety. They would be of equal value for the theatre. A printed blank can readily be devised for each case. This should cover the completeness and operative condition of all valves, fire hose, sprinklers, fire pails, soda water extinguishers, hooks, fire doors, exit locks and latches, smoke vents, fire curtain mechanism, and particularly of the neatness, cleanliness and order of every room, passageway, closet, air chamber, loft, basement and fly gallery, used as a part of the theatre building. This inspection should be made on each Monday afternoon, since the week end is the time when attractions are commonly changed.

"A private fire brigade from the regular stage hands and ushers should be drilled regularly, the Monday drill to be a wet drill testing the stage hose and a few of the soda water extinguishers, which may be turned out of the window to the areaway or into some convenient drain provided for the purpose at the rear of the stage. The head stage carpenter should always be present during a performance as chief of this brigade.

"If the municipal ordinance required such reports and drills as just described and that a duplicate of the report be filed each Monday afternoon with the public fire chief of the district, a single fireman or inspector detailed as instructor to cover all the theatres of a large city would, in my judgment, accomplish more real good than the two stage firemen required by law to be present from the public force.

RAILWAY MOTOR CARS.

APPLICATIONS OF STEAM AND INTERNAL-COMBUSTION MOTORS TO THE PROPULSION OF INDEPENDENT VEHICLES ON RAILWAYS.

A. Heller—Verein Deutscher Ingenieure.

THE success which has attended the development of the automobile vehicle for use of streets and highways has naturally led to the design of self-propelled cars for special service on railways, and for many purposes where it is not desirable to employ a locomotive and train such independent vehicles have come into use.

In a paper recently presented before the *Verein Deutscher Ingenieure* by Herr A. Heller, and published in the *Zeitschrift* of the society, there is given an extended review of the motor cars now in use on the Continent and in Great Britain, these including both steam propelled cars and those using internal-combustion motors similar to the engines of the heavier automobiles, employing benzine or gasoline as fuel.

Independent motor vehicles are generally used for local service on short feeder lines, but in some cases they are used either alone or to haul short trains of trailer cars on main lines. An example in point is cited in the case of the Great Western Railway at Swindon, where independent motor cars on the main line have been used to compete with a trackless electric omnibus service which paralleled the railway for about seven miles. Other applications have been found for such vehicles to fill in the service between the stops of express trains, for the replacement of special trains, and for many occasions for short local services for which the cost of regular trains would be found excessive.

The independent motor car is essentially intended to be a separate vehicle, and its use to haul trailers is limited to a few light cars to meet extra demands for transport or for the hauling of baggage or small quantities of merchandise. Practically all the cars described by Mr. Heller consist of a combination design, the propelling machinery being arranged at one end or beneath, the rest of the vehicle containing seats for passengers, some of these cars seating 50 passengers.

A large number of the vehicles now in use on steam railways are propelled by steam motors, a favorite type having horizontal cylinders beneath, and a vertical steam boiler at one side of the motorman's compartment in front. Some of these machines have high-pressure cylinders only, while others are arranged with cylinders of unequal diameter, permitting compounding upon the system employed in the United States for such service by Baxter as long ago as 1875, and in France by Mallet about the same time. Water-tube boilers of various types have been introduced for this service, the machine built for the Northern Railway of France, having the well-known Turgan boiler, while the vehicles constructed by Ganz & Co., of Budapest, have a vertical shell boiler with an inner shell and short water-tubes between the two shells. For large powers, i. e., for motors of about 100 horse power, two such boilers are used, this permitting a convenient arrangement, and allowing of alternating firing. In some cases, as in the steam motor cars of Komarek, of Vienna, superheating is employed, the Komarek boiler being of the coil water-tube type, with separate steam drum.

The application of internal-combustion motors to railway motor cars naturally follows from the successful results which have been attained with such motors in automobiles. Thus the Daimler company have made several sizes of motor vehicles, operated by motors similar to those designed for road automobiles, while on the North-Eastern Railway a mixed design has been used, this consisting of an internal-combustion motor driving a dynamo, supplying electric motors by which the car is propelled, a storage battery supplying current when the motor is not running.

The reduction in resistance offered by tracks over the rough surface of common roads renders it practicable to obtain a much higher tractive efficiency than is possible upon ordinary highways, and hence the motors which are supplied to automo-

biles carrying but a few riders are amply powerful to transport a large number of passengers in cars running on railways. Motors of 10 to 30 horse power are found sufficient to propel cars at speeds ranging from 30 to 60 kilometres per hour, carrying 30 to 50 passengers.

As an example of the economy of such cars for local passenger service, Herr Heller shows that for the transport of 150 passengers under ordinary conditions there would be required a locomotive, weighing at least 25 tons, and three passenger carriages of 15 tons weight each, or a total of about 70 tons. The same number of people could readily be transported with one motor car and two trailers having a total weight of less than 45 tons, with a corresponding reduction in fuel and wear.

The advantages of motor railway cars must be apparent to railroad men when the opportunities which they offer for reductions in operating costs are considered. It is not claimed that they are directly economical in fuel consumption, but the proportion of dead to paying load is far lower than can be attained for ordinary local trains, while the facility of operation and the low cost for operating crews combine to minimize the total expense. When run in connection with branch feeder lines they may be made most useful in the gathering of local traffic at main stations, thus enabling steam roads to meet the serious competition of electric and interurban lines. For inspection purposes and for the occasional demand for special transportation the motor car offers obvious advantages over the trains now used for such service, and there is every reason to believe that such machines will come into extensive use, even on the great trunk lines.

SPEED TRIALS OF NAVAL VESSELS.

METHODS USED IN ACTUAL PRACTICE FOR MEASURING THE TRIAL SPEEDS OF VESSELS FOR THE AMERICAN NAVY.

J. J. Woodward, U. S. N.—Society of Naval Architects and Marine Engineers.

AMONG the papers presented at the recent convention of the Society of Naval Architects and Marine Engineers we note one by Naval Constructor J. J. Woodward upon the important subject of the methods of conducting speed trials in the United States Navy. As Mr. Woodward remarks, this is one of those important problems for which we have only approximate and not exact solutions.

After reviewing the historical side of the subject, and showing the unreliability of the old-fashioned chip log and of the so-called patent log, Mr. Woodward proceeds to compare the contract trial requirements in the navies of the United States and Great Britain, and calls attention to the tendency in both countries to demand endurance and economy trials as well as the determination of speed.

Referring more especially to the methods employed in the United States, Mr. Woodward describes at length the manner in which the trial course at Cape Ann is laid out and marked, this being so arranged as to permit runs of 33 or 44 nautical miles, the positions of the buoys being determined by ranges and angles from points on shore. The depth of water along the course has been determined by careful soundings, it being generally 40 fathoms or more, there being two lumps of about 25 fathoms and one between 30 and 40 fathoms.

Referring to the observations made to determine the influence of currents upon speeds, Mr. Woodward gives these as they are now conducted, but does not hesitate to express the opinion of himself and other officers that these can be nothing more than approximations with little real value. The detailed operations involved in the conduct of a speed trial and the method of combining the observations are given at length, but for these the reader must be referred to the original papers. The treatment given is that of the French Naval Constructors Pollard and Dudebout. From the data obtained during the trial a speed curve can be constructed, and from this curve a number of important relations concerning the vessel may be deduced. Of these relations two of the most important may be considered, these being the exact determination of the true speed through

the water and the corresponding number of revolutions of the engines when the vessel is run at her highest speed over the mile course; and, the accurate determination of the direction of the speed horsepower curve where it passes through the point of maximum speed.

"In considering the first of these requirements, especial weight should be given to the fact that, even with a properly established trial course, our observations are subjected to accidental errors owing to irregular fluctuations in the current and to variations in the personal equations of the observers, so that a considerable number of observations are essential if reliance is to be placed on the result. The minimum number of runs that would appear to be satisfactory for this purpose is five. The French Admiralty method of combining the results of this number of runs is especially desirable since it permits an immediate appreciation during the trial of the regularity with which the current is varying. This follows from the fact if the speeds resulting from the averages of these two sub-groups differ to any noticeable extent, it may be immediately observed and the number of runs at this highest speed may be increased until a sufficient number are obtained to insure that irregularities in the results due to errors in one or more of the observations shall not materially affect the final value determined for this highest speed.

"The determination of the direction of the curve at its upper extremity theoretically requires only a knowledge of the position of one other point in the curve, which should be located sufficiently near the point of highest speed to permit a line joining the two points to represent the tangent to the curve at its highest points. With this information, the speed on a four-hour trial could be accurately determined whenever this speed only differed from the highest speed observed in the standardization trial, by a small fraction of a knot. The accuracy of this method of the determination of the speed on a four hours' trial, would however, rapidly decrease as the difference between the speeds increased; and such a method would moreover afford the minimum general information as to the efficiency of the ship and its machinery, for a given number of runs over the measured mile. This is evident, since to construct the tangent we must know the position of the second spot on the curve with the same accuracy as the first, which would require five additional runs at a speed only slightly lower than the highest speed obtained on the mile course. Ten runs would, therefore, have been made, all at powers requiring forced draught to the maximum, or nearly maximum permissible amount, and the net result would be the determination of two neighboring points on the speed power curve.

"If instead of limiting the investigation of the speeds developed on the measured mile, so that it will furnish only the minimum amount of information required to determine the speed during a four-hour full power trial, a larger number of points of the speed power curve are established through such a range of speeds that a considerable part of the upper portion of this curve is determined, it will be found that although the number of runs over the mile course is increased, the difficulty of conducting a successful trial is diminished, since the number of runs at the higher speeds may be materially reduced. The propriety of this reduction will be plainly seen if it is remembered that since it is now proposed to determine a number of points on this curve, the runs made at other than the very highest speed can be made in a series of gradually reduced speeds, for which the corresponding horse powers fall even more rapidly. The desirability of making a number of runs at considerably less than full power is the more evident if it is further remembered that since we are now determining the direction of the curve at its upper extremity by establishing the position of a number of its points, it is obvious that if we restrict the observations made to the immediate neighborhood of the upper extremity of the curve, irregularities in the observations of any given amounts will affect the resulting determination of points further removed from the curve's upper extremity."

The trials of vessels are made primarily to demonstrate that the purchaser, that is, the government, has obtained what it is paying for, but apart from this the infor-

mation obtained as to the relations between power and speed should be most useful in the future handling of the vessel. If the relations between the revolutions of the propeller and the speed of the vessel have been accurately determined the officers of the vessel will be supplied with data of great value for the determination of the speed at any time, experience having shown that the propeller is by far the best log which can be supplied, if only it has been accurately calibrated upon an accurately measured course. However opinions may differ as to the advisability of making the payments for a vessel conditional upon the results of her speed trials, there is no question as to the usefulness of such trials in determining data for the subsequent operation of the ship.

"In view of the present state of the art of construction of vessels for military purposes, it is essential to insure efficiency that the contracts for such vessels should provide, not only for a full power trial of a few hours' duration, but also for additional trials each lasting at least 30 hours in order to determine:

"The endurance of the propelling machinery at the highest power that can be continuously maintained at sea;

"The economy of coal consumption at a cruising speed—approximately that corresponding to the maximum cruising radius of the vessel.

"It is believed to be imperative, in order to properly care for the matériel of the vessel, that such trials should be conducted by a naval crew, the builder to have, however, as many men on board as he may desire and to retain full control and responsibility for the operation of the machinery which he has built. Such a procedure would follow the practice of all other first-class naval powers.

FUEL GAS PRODUCTION.

A REVIEW OF THE PRODUCER GAS TESTS OF THE UNITED STATES GEOLOGICAL SURVEY COAL TESTING PLANT AT ST. LOUIS.

R. H. Fernald—American Society of Mechanical Engineers.

IN previous issues of this Magazine the general equipment of the coal testing plant at the St. Louis exposition has been fully described, and a summary of the methods of work and the results given in papers written by Mr. Parker. Since that time the work of the Geological Survey has been continued, and an additional appropriation made by Congress has enabled this important department of technical investigation to be extended.

In a valuable paper presented at the recent convention of the American Society of Mechanical Engineers by Professor R. H. Fernald, himself actively connected with this important piece of research work, an account is given of the results which have been obtained with fuels of various grades when consumed in the gas producer.

Professor Fernald called especial attention to the fact that the tests were tests of fuels and not of producers. All the tests were made in the same producer, one originally designed for use with anthracite coal, and this apparatus was necessarily not equally well adapted for bituminous coal, for lignites, and for anthracite. Under the conditions governing the tests it was impracticable to adapt the producer especially to the fuel, but on the whole the results were faily satisfactory. Each fuel was tested, both in the producer and under a boiler, the gas from the producer being used to operate a Westinghouse gas engine, while the steam from the boiler drove a Corliss engine, the power in each case being converted into electrical energy and thus measured. In this way there were obtained results showing the advantages obtained by the use of the producer over the boiler. The tabulated results of these comparative tests show that in nineteen different trials the quantity of dry fuel required for the development of one electrical horse power was more than twice as much for the steam plant as for the gas plant. In fact, the ratio of the coal consumed per horse power by the gas plant to that required for the steam plant is given as 2.57 or more than two and one-half times in favor of the gas plant.

It may be argued that such a marked difference would not appear if a triple-expansion condensing engine were used in the steam tests, instead of a simple non-condensing Corliss engine. Mr. Fernald calls attention to the fact, however, that the gas engine employed was by no means of the most modern design nor economical type, and maintains that if the most modern steam plant were compared with a correspondingly modern and well adjusted gas plant, the ratio of fuel consumption would be about the same as that shown in the present tests.

The calorific value of the gas depended somewhat upon the nature of the fuel, ranging from about 140 British thermal units per cubic foot of gas to 188 thermal units. This latter result was obtained with a lignite from North Dakota, a fuel containing so much moisture as to be considered altogether unsuited for use under steam boilers, but evidently well adapted for the gas producer. The presence of the moisture resulted in the production of a partial water-gas, the gas from this fuel showing upon analysis more than 14 per cent. of hydrogen.

The demonstration which these trials have made as to the adaptability of so-called low-grade fuels to the production of fuel-gas for gas engines is one of the most noteworthy results which have followed the conduct of the researches upon the coal testing plant of the Geological Survey. The expenditure of a few thousand dollars in these tests will doubtless result in the utilization of beds of fuel hitherto neglected as being commercially worthless, while the impetus which the investigations will give to the industry of building producers and gas engines cannot but be very marked.

So far as the actual performance of the gas plant is concerned, the results have demonstrated very fully the efficiency of the gas producer and gas engine as a means of obtaining energy from coal. The official records show that performances as low as 0.95 pound of dry coal burned in the producer per electrical horse power at the switchboard have been obtained. This includes the efficiency of the dynamo and its belt transmission, and taking the efficiency of this portion at 85 per cent. we get a consumption of 0.8 pound of coal per horse power.

The determination of the amount of coal actually burned in the producer for any given period is, at best, a factor of more or less uncertainty. To reduce this possible error to a minimum it was deemed necessary to make the test on each coal as long as consistent. A schedule was therefore adopted at the beginning of this series of tests, involving two sixty-hour runs per week. The first eight to twelve hours of each test period are used for getting the fuel-bed into a uniform and efficient condition. During these preliminary hours records are taken as in the regular tests, but the official test, as reported, included only the last forty-eight or fifty hours of the run, during which time the conditions are maintained as uniform as possible.

To carry out this schedule it became necessary to add a second producer to the plant, so that the plant now consists of two independent producers both discharging into the same scrubber. These producers are worked independently, one being charged while the other is in operation. By this arrangement no time is lost in changing from one coal to another at the end of any test, as a simple manipulation of valves brings the second producer into operation when the first is cut out.

Owing to the lack of reliability in the operation of the gas engine, many of the tests conducted during the Exposition period were of a few hours' duration only, but since the present series of tests began (May, 1905) no difficulty has been experienced in starting the engine at 8 A. M. Monday and continuing day and night without a stop until 8 A. M. Saturday. During this period two different coals are tested and the change of gases is made at 8 A. M. Wednesday without stopping the engine.

An effort to do away with unnecessary appliances has furnished valuable and interesting information and has centered attention on several radical changes in the details of producer-gas plant construction.

It developed at an early date that more or less sulphur was passing the purifier and entering the engine cylinders. Investigations by the chemists showed that purifiers consisting of oxidized iron-filings and shavings were fairly efficient for coals contain-

ing little sulphur—one per cent. or less; but it was found that for coals containing larger percentages of sulphur the purifier was exhausted after about six or eight hours. Mixtures of lime and shavings were tried, but with little success. As a result of these investigations the purifier has been discarded and the gas, carrying its full percentage of sulphur, has been charged directly into the engine cylinders. This method of operating has been going on for many months and no ill effects have been discovered although coal has been used which runs as high as 8.1 per cent. sulphur.

One feature of the plant as installed was the economizer, used for preheating the air for the blast. A series of experiments has shown no effect upon the chemical composition of the gas or upon the efficiency of the plant when air at ordinary atmospheric temperature was substituted for preheated air. As a result the economizer, as an economizer, has been discarded, and the construction of the plant again simplified.

Other modifications and changes are under investigation at the present time, the most important from an economic standpoint relating to the utilization of slack coal in producers.

CONDENSERS FOR STEAM TURBINES.

METHODS FOR THE PRODUCTION OF THE MOST ECONOMICAL VACUUM FOR STEAM ENGINES AND TURBINES.

Frank Foster—Owens College Engineering Society.

IN the early history of the steam engine the separate condenser was an object of great interest, and in spite of the efforts of such pioneers as Trevithick and Oliver Evans the older engineers relied upon the vacuum on the exhaust side of the piston for the greater portion of the power produced by the engine. Later the high pressure engine assumed its position, and in many cases where water supply was limited, and fuel cheap, the condenser was omitted, while the development of the locomotive engine showed the possibilities of the engine which exhausted its steam against atmospheric pressure. Since the introduction of the steam turbine the importance of the maintenance of a good vacuum has been generally appreciated and numerous discussions have been made to show the superior performance of the turbine against a low back pressure.

In a paper recently presented by Mr. Frank Foster before the Engineering Society of Owens College the whole subject of modern condensers is reviewed at length, together with the important question as to the most economical vacuum, considered from the total efficiency of the plant.

The various types of condensers may be included in the following classification: Surface condensers; Barometric jet condensers; Non-barometric jet condensers; Ejector condensers; Evaporative surface condensers. These are described in detail by Mr. Foster, and the advantages of the barometric types shown, so far as vacuum and space required are concerned.

"The choice of a condenser depends a good deal on the working conditions. Where there is a plentiful and cheap supply of good condensing water suitable for boiler feed, a barometric injection condenser will generally be found most reliable, and generally suitable, especially so if floor space is expensive.

"Where the condensing water is not suitable for boiler feed, and where on the other hand it is not so dirty as to seriously impair the efficiency of a surface condenser by coating the tubes with sediment, then a surface condenser is as a rule preferable. The use of surface condensers on sea-going ships will illustrate the above case.

"Where the condensing water is difficult to obtain in large quantities, a barometric condenser is preferable to a surface condenser in most cases, as it uses less water —from 15 to 60 per cent. less, according to the vacuum and water temperature—and this also reduces the size of the cooling tower which must often be used. If, however, the condensing water is also of poor quality, so that it is not suitable for boiler feed, it may be desirable to use a surface condenser, especially if the vacuum is not very high.

"There is little doubt, the writer believes, but that the merits of the barometric condenser will come to be more widely recognised, and that in both turbine and reciprocating work they will largely replace surface condensers for land installations. For use with horizontal turbines the height of the barometric head above the turbine floor is a small drawback in many cases."

In considering the subject of surface condensers, Mr. Foster considers the question of the velocity of flow of the condensing water, giving the formula of Stanton for various temperatures of inlet and discharge water. There is no doubt that the vacuum is improved by giving the water a high velocity, but this is attainable only by an increased load upon the circulating pump, so that the gain on the one hand must have the increased resistance on the other offset against it.

"It appears from Stanton's formulæ and is confirmed by his experiments on actual condensers—that the outlet temperature is very little affected by the velocity of water in the tubes (the inlet temperature, the length of the tube, and the tube temperature remaining unaltered), falling off, however, a little as the velocity increases. Neglecting this small variation for the sake of simplicity, we see that as the total water passing through a tube is proportional to the velocity, the quantity of heat abstracted from the steam will be proportional to the velocity, and hence the number of tubes and the tube surface will be inversely proportional to the velocity of the water.

"Clearly, then, the cost of the condenser can be reduced by using water flowing at a high velocity. A high water velocity will send up the power required for the circulating pump roughly as the velocity, and this will tend to increase the cost of the condensing plant as a whole, as well as the cost of running the plant, so that there is evidently a limit to the velocity which is economically desirable.

"So long as the time factor—the proportion of the year during which the plant is running—does not exceed 12 per cent. the higher velocity is more economical than the lower. The *higher* the cost of fuel the *lower* this time factor. Within limits, the higher the velocity the greater the gain for time factors lower than 12 per cent.

"Clearly, then, as a general principle we may say that high water velocities are not desirable for plants which run fairly continuously, as in the case of marine and factory installations."

The question of the cost of cooling water is also considered by Mr. Foster. The extreme variations in this cost in various localities renders it impossible to give anything but a general consideration, but some fundamental principles may be examined. In general the extra expense of cooling ponds and towers is offset by the gain in fuel economy in proportion to the load factor and to the price of fuel. It follows that such things may be found desirable for a factory plant and at the same time unprofitable for an electric lighting plant.

Without attempting to examine into the reasons for the increased efficiency of steam turbines at high vacuum, Mr. Foster gives data and results from tests showing that there is a reduction in steam consumption of about 0.56 pounds per inch of vacuum per kilowatt per hour. If this were all we could not get too good a vacuum, but a comparison of the costs of condensing equipments shows that a 28.5 inch plant costs more than twice as much as a 26-inch plant, so that interest and depreciation charges must be taken into account.

"Now the most economical vacuum will be that at which the rate of increase in the fixed charges is just equal to the rate of decrease in the fuel cost, and not when the fixed charges themselves are equal to the reduction (total) in the cost of fuel; for when this former balance has been reached, then any *further* small increase in the vacuum costs more than the reduction in fuel cost it produces, yet the total reduction in fuel cost will be more than the total fixed charges. This point is very important, so we will illustrate it by an analogy.

"Suppose a business firm to try to increase their business by opening branches. Then they will cease to add to the number of branches when these new branches cease to pay for themselves, and not when the losses on these new branches just balance the profits on the older ones, and thus make the profit over the whole system of branches nothing."

By comparing a number of installations Mr. Foster shows the influence which the

load factor of a station has upon this subject, and it is evident that a plant in which the load factor is low should not have condensers at all. The load factor of electric lighting stations is almost invariably low, the average factor of eight British stations ranging from 13 to 16 per cent.

"It would seem at first glance, therefore, that, except where coal is expensive, all these plants ought to be run non-condensing. A little thought will show us, however, that there is another course open to us which offers many advantages, and that is to provide condensing equipment for some engines—or turbines—only.

"Of course each installation must be considered separately and due weight given to the particular conditions of such things as cost of coal, water, and land, and the quality of the condensing water. Still it may be stated as well within the mark that in the majority of electric power stations only a portion of the engine plant ought to be equipped with condensers. The engine equipments of a factory have very different load factors, depending largely on the nature of the work done in the factory. In textile factories this load factor is often 25 per cent. and sometimes as high as 30 per cent., so that in general we may say that the engine ought to have a condenser. In large belt or rope driven engineering workshops the load factor is generally fairly high, and in works where there is a considerable night shift the load factor on one of the engines—if there are two or more—may be as high as 50 per cent.

"Where the factory load varies according to the time of the day and year, as is particularly the case with electrically-driven and lighted shops, it is advisable to have two engines, one of which takes the light loads and assists in taking the peaks. Unless a night shift is run—which would usually be supplied with light and power from this small engine—this small engine should, generally speaking, not have a separate condenser."

EXPERIMENTAL TESTS OF SAFETY LAMPS.

PRACTICAL TRIALS OF MODERN MINING LAMPS AT THE OFFICIAL TESTING STATION IN BELGIUM.

H. Schmerber—Le Génie Civil.

EVER since the introduction of the safety lamp following the inventions of Davy and of Stephenson, there have been attempts made to improve and modify the apparatus for providing safe illumination for the miners who are obliged to work in localities producing explosive gases. In many countries the control and regulation of such lighting appliances has been assumed by the government, as being a matter within the jurisdiction of the State, and this has been especially the case in Belgium, where the coal mines are notably liable to emit volumes of explosive gases. In a recent issue of *Le Génie Civil* there is given an account of the operation of the official testing station at Frameries, from which we make some abstract, as being of value and interest to coal mining industries in other countries.

There appears to be little doubt that the mines in the bituminous coal district of Belgium are among the most gaseous in the world. According to Stassart, there are some mines in the district which have emitted 30,000 to 40,000 cubic metres of explosion gases daily for years, and in some minds it has been estimated that as much as 250 cubic metres of gas are disengaged for every ton of coal raised. Under such conditions it is evident that the subject of explosions becomes a most serious one, and the work of the *Service des Accidents Miniers et du Grisou*, as the department is termed, under the skilful charge of the chief engineer, M. Watteyne, is an important feature of industrial administration. The work of the department is divided into two parts, one relating to safety in illumination, and the other to the safe use of mining explosives, and it is of the former portion of the service that M. Schmerber treats in the article under consideration.

The Belgian government has established at Frameries a very complete equipment for enabling practical tests to be made of lamps and other appliances, the equipment including a laboratory machine shop, gas

holders, purifiers, and all necessary apparatus.

The gas used in testing the lamps is drawn from two seams about 700 metres below the surface, at a point where a fault has formed a sort of chamber not directly traversed by the workings of the mine, and it has been shown that at this point about 400 cubic metres of gas are disengaged daily. The gas is drawn through a pipe of 5 centimetres bore with walls 3 millimetres in thickness, the total length of the system being about 1,000 metres. Since the tightness of the pipe is an important matter it is so arranged that the lower end may be closed at any time, and the whole length tested by compressed air, this enabling any leak to be detected. It is also possible to draw off samples of gas from the lower end of the pipe and compare the composition with that delivered at the top, to see if any change has occurred during the passage.

The chamber in which the lamps are tested is so arranged that the lamp may be exposed, either wholly or in part, and in any position, to currents of the gas, at various velocities. The gas may also be charged with coal dust if so desired, and arrangements are also provided for testing the efficiency of relighting devices. Space is not available here for a detailed account of the apparatus and methods, but some of the more important conclusions may be given.

Three important questions have been thoroughly investigated at the Belgian testing station in connection with the use of safety mining lamps. The first of these is the possibility of permitting the use of mineral oils, instead of the vegetable oils hitherto prescribed. The second question, most important, is the practicability of relighting extinguished lamps within the mine; while the third point included the admission of a variety of lamps, rather than the enforcement of the rule compelling the use of a single prescribed type.

So far as the nature of the oil is concerned, it was formerly believed that mineral oils permitted the formation of explosive vapors, at least to a greater degree than was possible with vegetable oils. This question was definitely settled by the tests, it being conclusively shown that there was no greater danger with one type than with the other, while at the same type the lamps fed with essence, or with light mineral oils gave much better light and also afforded much better opportunity for the introduction of automatic relighting devices.

This question of relighting is a most important one. With all precautions in construction and care in use the lamps in service are apt to go out. Under the old regulations the miner was obliged to return with his lamp either to the surface, or to a lighting station, usually placed away from the workings and near the base of a ventilating shaft. This meant loss of time, and a tedious trip without a light, and has led in many cases to attempts by the miners to open the lamps, by false keys or otherwise, to permit relighting on the spot. Many explosions have been attributed to attempts at relighting lamps in explosive atmospheres, and a remedy for the practice is most desirable.

The lighting devices which have been tested consist of some sort of band or tape composed of paper or paraffined tissue, and containing at intervals small primers of phosphorus or other composition, ignitible by percussion or friction. If the lamp goes out this strip can be operated from without, the lamp remaining closed, and a fresh light thus obtained. The experiments showed that such devices are not always safe, since with some forms of lamps the flame produced by the relighting primer is found to traverse the gauze of the lamp and ignite the gas without.

Comparative tests of a number of lamps have shown that some of the later models are superior to the form previously given sole authorization for the Belgian mines, and it is probable that requirements of conformity to the tests of the department will be made the condition for use hereafter.

A number of careful tests of standard lamps have been made to show their behavior in the presence of coal dust, but the results have been wholly favorable, showing that the risks on this account are negligible. Other points of interest in connection with the tests relate to the material of the wire gauze. Although gauze of brass or copper wire has the advantage over iron as regards freedom from rust, the brass gauze is liable to fuse if overheated, and

this defect exists in a lesser degree with copper gauze. Formerly the glass portion of the lamp, about the flame, was made thick, in order to minimize danger of breakage. With the later lamps the heating is more rapid, and it is found that thinner glass is less liable to break from unequal expansion than the heavier material, especially when drops of water strike the exterior of the lamp.

It is evident that the systematic investigations of the real elements of safety and service of lamps in the Belgian mines have produced valuable results, and the experience thus gained may well be applied elsewhere.

THE ELECTRICAL TRANSMISSION OF INTELLIGENCE.

PROBLEMS OF ELECTRICAL ENGINEERING INVOLVED IN THE MAINTENANCE OF COMMUNICATION BY TELEGRAPH AND TELEPHONE.

John Gavey—Institution of Electrical Engineers.

ELECTRICAL engineering is generally assumed to be that department of the profession dealing with such questions as to operation of great generating stations, the transmission of heavy currents at high pressures for the development of mechanical energy, propelling tram cars, driving machinery, and other conspicuous and obvious applications, or for the production of numerous and brilliant lights.

It must not be forgotten, however, that most important results are produced, both technically and commercially by the applications of such weak currents as are employed for the transmission of intelligence by means of the telegraph and telephone. This department of electrical engineering formed the principal subject of the presidential address of Mr. John Gavey, recently delivered before the Institution of Electrical Engineers, the subject having especial appropriateness from the fact that the Institution itself is the outgrowth of a previous society of telegraph engineers.

After referring to the wide use of telegraphic appliances for special purposes, such as the regulation and control of railway signals, fire alarms, and the like, Mr. Gavey takes up the subject of ordinary telegraphs, giving some statistics to show the great development which has taken place between 1879 and 1904, both in Great Britain and in the United States.

Referring to the possibilities of future growth, Mr. Gavey points out that much depends upon the action of local authorities, since the insistence of methods which involve costs beyond the commercial possibilities of the business simply act to stifle the industry.

"If we now consider the actual apparatus by means of which commercial telegraphy is effected, perhaps the most surprising fact that strikes the observer is the predominance of the use of the ordinary Morse code and Morse apparatus throughout the world. At first it seems surprising that, notwithstanding the innumerable inventions of printing, writing, and drawing telegraphs, the original system—of course, much improved—still holds the field generally, notwithstanding the partial use of the Hughes and Baudot printing systems on the Continent of Europe. On consideration, however, it will no doubt be seen that, in comparing the Morse with other systems that at first would appear to be superior, its simplicity, its relative freedom from trouble, electrical or mechanical, the ease with which its alphabet is learned, and a skilled telegraphist is trained, and its adaptability to high-speed or multiplex working, all help to maintain it in the forefront, and undoubtedly qualities will for a long time prevent or delay its general replacement by other types of instrument where the speed of working that is necessary is not greater than can be achieved by an operator manipulating a key. Where high-speed automatic Morse apparatus, however, is in use, the want of a means of automatic transcription which would save the labour and delay of manual transcription has long been felt, and extremely promising systems have been devised whereby the problem has been solved in two different ways. In one which was recently illustrated in a paper read before the Institution a perforated slip is used for transmission, as in the ordinary Wheatstone system, but instead of the sig-

nals being received in Morse characters at the far end, a second slip is perforated, the exact counterpart of the original; this is placed in an automatic typewriter, which prints the message on ordinary typo. Two different methods of applying this system are now under the consideration of the Post Office. In others the transmission is effected by means of a perforated tape, the message, however, being printed by the receiving instrument, either by a direct impression from a type-wheel, or in one case by a photographic reproduction of each letter as the type-wheel revolves."

The subject of space telegraphy is discussed by Mr. Gavey, reviewing the development from the early experiments by the induction through the progress which has been made in the application of the phenomena of Hertzian waves, through the work of Branly, Lodge, Marconi and their associates and followers.

"A great deal has been said by rival inventors as to the possibilities of wireless telegraphy, and some exaggerated claims have been made on their behalf which have led to counter statements by some interested in other methods of communication. Whilst, on the one hand, it may be fairly assumed that wireless telegraphy is not, under any circumstances, likely to supplant, or even to compete seriously with, inland methods of intercommunication, there is no doubt that there is a very distinct and important sphere of utility awaiting its further development. For intercommunication between ship and shore, and ship and ship, much has been done, although much remains to be done. For intercommunication between neighbouring coasts there is also a possible future, but this depends almost wholly on the further development of the methods of syntony or tuning. There appears to be doubt that in cases in which the wave-lengths used on two systems differ to a considerable extent, a very marked degree of success has been obtained in the avoidance of mutual interference. Where the wave-lengths, however, are not very widely apart in frequency, there is in each case a definite range within which interference arises, and simultaneous working is impossible. That the tuning methods will be improved I think there can be very little doubt. The progress that has been made between the year 1896, when it took a week to receive a few elementary signals over a distance of nine miles, and the present time, when such remarkable results have actually been obtained, is so great that it does not imply the possession of an unduly sanguine disposition if one ventures to predict further improvements, which may be expected to increase the freedom from mutual interference, the speed, and the reliability of this method of communication. It does not appear to be very probable that it will seriously compete with the highly-developed cable communication in the near future, although it may in many instances supplement that service."

Passing over some interesting remarks on the development of telegraph-line construction, and the growth of underground cables, Mr. Gavey touches upon the present status of the telephone problem.

"Not the least remarkable of the modern developments of electrical engineering is the extraordinary growth of the telephone service throughout the whole of the world. Subsequent to the year 1860, when Reis invented his musical telephone, it was thought by the majority of electricians that no further approach towards the attainment of articulate speech could be made. The possibilities attending the use of loose contacts, at that time the most dreaded enemy of the electrical engineer, had not been foreseen, and the conclusion was generally arrived at that it would be impossible to devise a transmitter free from the defect of causing actual breaks in continuity so as to admit of the delicate curves necessary for the transmission of articulate speech being reproduced electrically. Bell's invention in 1876 was received almost in a spirit of incredulity, and when in the following year it was brought to this country, it was looked upon as a marvellous development.

"As the result of successive inventions, a steady and rapid improvement in the indoor plant available for exchange work has taken place, and so far as modern telephone switch is concerned, these improvements have been wholly in the direction of reducing the amount of talk on the part of the operator that was necessary under the old conditions. This has been brought about by the provision of a complete system of automatic signalling, whereby she

is kept abreast of her work, so that, with the exception of asking for the number of the subscriber who is wanted, there should in all ordinary cases be no need for conversation between the subscriber and the operator, this being accompanied by a corresponding increase in the speed of working. In fact, one system goes so far as to render it unnecessary even to ask for the number of the subscriber required, that information being printed by the caller on a Morse slip. This tendency to reduce the operators to a species of intelligent automaton naturally suggests the possibility of the entire elimination of the operator, and the introduction of suitable automatic apparatus at the exchange. Several very ingenious methods of attaining this end have been devised, and one system has achieved a certain measure of success in America, several exchanges of some magnitude having been equipped with apparatus of this type."

The limits to which speech can be transmitted by telephone have by no means been determined, and in England, as in Germany and the United States, experiments with the Pupin coils have resulted in very materially extending the distance to which clear articulation can be sent. This subject is doubtless open to still further improvement, and no one at present is prepared to make any definite statement as to the limitations of long-distance telephony.

In closing his address Mr. Gavey referred to some of the unsolved problems existing in connection with electrical methods of communication. These include the improvement of high-speed telegraphic systems so as to permit the direct reception of legible records, suitable for immediate delivery to the public or the press.

Another question upon which much labor is being expended is the tuning of receivers in space telegraphy, and still another is the design of an effective telephone relay. The telephone switchboard appears to have reached its limitations in some respects, but the problem of its extension cannot yet be considered as insoluble.

These and many other lines of further development remain open for the electrical engineer, and both in interest and in commercial value they compare fully with the more conspicuous work in the electrical transmission of mechanical energy.

INTERNAL COMBUSTION MOTOR CONSTRUCTION

THE PRESENT PRACTICE OF CONTINENTAL ENGINEERS IN THE DESIGN, CONSTRUCTION AND OPERATION OF GAS ENGINES.

R. E. Mathot—Liége Engineering Congress.

AMONG the valuable papers presented at the International Congress of Mining, Metallurgy and Engineering held in connection with the recent exposition at Liége, we select the communication from M. R. E. Mathot, the well-known expert in internal-combustion motors, since this exhaustive paper gives an excellent résumé of the present state of the art in this important department of engineering.

At the outset M. Mathot calls attention to the consideration which is being given to the four-cycle and the two-cycle forms of motor. So far from advocating either of these to the disparagement of the other, he believes that each has its good features, and that the choice of cycle should be governed by the actual conditions obtaining in any case under consideration.

Four important features are enumerated as involved in the design of an internal-combustion motor: the ignition, the compression, the cooling, and the speed regulation, and these are taken up in order, with examples from the construction of the leading Continental builders.

At the present time the electric spark ignition, using the magneto, is generally employed as being most satisfactory. This system is not only reliable, but especially convenient from the facility with which it permits the use of devices for advancing or delaying the moment of ignition. The only improvement calling for notice is the practice of using two independent ignition devices, with separate spark plugs, this assuring a more uniform ignition of the charge, and providing against accidents.

The subject of compression has attracted

much discussion of late, and some engineers are advocating compressions as high as 15 to 16 atmospheres, or 210 to 225 pounds per square inch. The true consideration which should govern the choice of compression is the nature of the gas employed; the degree of compression being such as to avoid all dangers of premature ignition, while at the same time effecting the complete combustion of the charge, however lean the gas employed.

M. Mathot believes that good results will be attained in general by the use of compressions of 9 to 10 kilogrammes per square centimetre, or 128 to 142 pounds per square inch, this assuring an excellent combustion of charges having a calorific power of 550 to 600 calories, or 62 to 67 British thermal units per cubic foot, formed by using 50 per cent. mixtures from suction producer gas of double this calorific power. The presence of hydrocarbons, and particularly of hydrogen, insures a prompt and rapid combustion, even with low compressions.

Tight compressions are generally required for blast-furnace gases, and gases of similar lean composition, and in designing engines for such fuel the degree of compression should be increased in inverse proportion to the calorific power of the fuel.

The refrigeration of the working parts is an inevitable source of loss in efficiency, but, as M. Mathot points out, the heat carried off by the cooling water is in a convenient form for recovery.

The present practice in England, using low degrees of compression, is to jacket the cylinder only, but on the Continent, where higher compressions are used, the exhaust valve is also cooled for engines above 60 horse power, while for sizes of 150 horse power and upwards the water is also circulated through the piston. In the former case from 18 to 20 litres of water are required per horse power per hour, and in the latter from 25 to 30 litres, this being found sufficient to prevent premature ignitions or injurious action to the materials.

The question of regulation of speed is one of the most important elements in gas-engine design, and to it M. Mathot gives much attention.

The old method of "hit-or-miss" governing is now applied only to engines of moderate size, especially in England, while the Continental engineers, followed by the Americans, have availed themselves of more scientific methods. There is no question that the "hit-or-miss" method conduces to a high degree of economy, and that it permits the use of a sensitive governor of small size with a minimum of work to perform. It does not conduce, however, to the smooth and uniform action which the gas engine should have in order to compete effectively with its rival, the steam engine. M. Mathot gives some interesting studies of the action of engines having this type of regulator, using his continuously-recording indicator for presenting an accurate record of the impulses upon the piston.

While the "hit-or-miss" method is applicable to small engines, and has the advantage of permitting the gas mixture to be adjusted once for all, it is manifestly unsuited for the large modern engines, in which a full power stroke, succeeding one or several idle strokes, would produce an undesirable violence of action. It has therefore become necessary to devise some method of more continuous regulation, permitting the use of fly wheels of moderate weight, and permitting a smooth and steady action.

The methods of governing at present employed by the Continental designers are of two principal types. The first of these controls the speed by varying the proportions of the charge, without altering the total quantity admitted. The mechanism of the governor acts upon the gas valve in such a manner as to alter the quantity of gas admitted; the volume of air remaining constant. The result is a variation in the force of the explosion and consequently of the power of the stroke. The principal objection to this method appears in the fact that with light loads the proportion of gas in the charge becomes so low that there is difficulty in effecting the ignition unless the compression is made very high. If the compression is high, however, there is danger of premature ignitions when a full supply of gas is admitted, so that this method of governing appears to be well adapted only for cases in which the variations of load are not great.

The other method of governing is that in which the quality of the charge remains

unchanged, the quantity admitted varying according to the demands of the load. In this method either a separate throttling valve is operated by the governor, or else this latter acts upon the mixing valve itself. In either case the proportion of air and gas in the charge remains unchanged, but the total volume entering the cylinder is varied with the load. When the volume of charge admitted is small, as in the case of light loads, the compression will be reduced, so that a fairly high degree of normal compression must be provided in designing engines to be governed in this way. On the whole, it is found to work well in practice, giving smooth action and good economy.

M. Mathot's paper contains some interesting reports of tests of gas engines, and numerous detailed illustrations of the working parts of engines by the principal Continental builders.

MACHINE-SHOP PRACTICE.

THE ARRANGEMENT AND GENERAL MANAGEMENT OF THE MODERN MACHINE SHOP, WITH ESPECIAL REFERENCE TO RAILROAD PRACTICE.

G. M. Campbell—Engineers' Society of Western Pennsylvania.

THE growth of the modern machine shop includes within itself nearly all the elements of progress in mechanical engineering. Motive power, power transmission, machine-tool design and operation, materials of production and construction, building design, applied electricity, both for power and for lighting, all these are included, and to them must be added the management of men, the arrangement and care of rough and finished stores, together with a satisfactory system of finding, distributing and recording costs. It is evident that many of these subjects involve whole series of comprehensive articles themselves for their exemplification, and reference to past issues of this magazine and other technical publications will show many such papers. An excellent presentation of the whole subject in a general way is found in a paper recently presented by Mr. G. M. Campbell, before the Engineers' Society of Western Pennsylvania, and published in the *Proceedings* of the society, and some abstract of this discussion will be found of interest and value.

"The general management of a large machine shop is a subject in itself. The control over the shop should be very complete, and as much a one-man control as possible, not that one man should actually supervise the shop but that he should control every department through competent assistants, each assistant or foreman having trusted foreman or sub-foreman under him. The utmost care should be taken to have all the work performed systematically, so that the time lost in handling work is reduced to a minimum. Again, the utmost care should be taken to turn out good work, for in the end any concern doing poor work is doomed to failure; not only should the workmanship be good, but the parts turned out should all be to gauge within a pre-determined limit of error, the allowable error being determined by means of limit gauges.

"The general scheme of handling the men, whether by day work, piece work, premium or other systems, is also a subject in itself. Each system has advantages and disadvantages. The men should be under careful supervision, but at the same time not watched as if they were trying to cheat the company. A speed foreman or a man whose duty it is to speed up the tools to the proper point is generally obnoxious to the men unless he has exceptional tact. The work can be done by a sub-foreman without the special title. The good will of the men should, as far as possible, be obtained by making the surroundings comfortable and healthy and paying a good wage to keep good men."

Two elements of vital importance in a well managed shop are an efficient tool room and a good stores system.

The tool room itself may be considered as the standard of excellence for the rest of the shop as regards the high class of the machines in it, and the care with which they are operated, while upon the careful arrangement and management of the stores department much of the profit or loss of the establishment will depend.

"One machine—one tool—one man, was the old rule since the operation of the first machine, and if some short-sighted trades unions had their way, would still be in force. But such is no longer the case in live machine shops. Many single spindled drills are, for special work, replaced by multiple spindled drills, so that with one operation half a dozen or more holes are drilled, gaining very greatly in time and also in having the output absolutely interchangeable, a point of the very highest value. Single-headed planers are now the exception except in small sizes; planers cutting on both the forward and return stroke have been used but are not generally approved; plate edge planing machines cut both ways with entire satisfaction. Lathes also have multiple cutting tools, two, three and four. Locomotive driving wheel lathes, for example, can have its two wheels and two bearings machined simultaneously, though duplex machines are the general ones used. Shafting lathes have usually three tools operating, gun lathes, four, etc. Vertical boring mills have usually two heads. Turret lathes in their many modifications are a slightly different example of multiplying tools. The different tools are contained in one machine, but usually one tool operates at a time, the saving in time being effected by the extreme ease of changing from one tool to another."

The general character of the tools in any shop must naturally depend upon the nature of the product. Automatic machines are a paying investment when the number of pieces of one kind is so large that the time required to set the mechanism is small compared to the time the machine will be in operation. The capital and interest should be balanced against the saving in attendance.

Many things formerly done by hand are now performed by machinery. Pneumatic chippers and riveters replace the hand methods; portable grinders and drills take the place of the file and the ratchet, and in many cases it is found easier to take the tools to the work than to set a large piece of work on the machine. The electric traveling crane, with auxiliary localized hoists, takes the place of the large laboring gangs formerly used, and wherever possible the skill of the workman is used rather than the mere exertion of his physical strength.

"The discovery of the value of certain steel alloys is one of the greatest of the age in regard to machine shop practice. Its value is far-reaching, not only in greatly decreasing the time required for an operation but also in leading machine shop men to investigate all connecting problems, such as the strength and better design of machines, the time required for handling and chucking the work, etc. If, under old conditions, a certain operation in a machine required three hours' time and one hour for chucking and handling, the idle time of the machine would be only 25 per cent. of the total, if the time of the operation were reduced by the use of high speed steels to one hour then the idle time would be 50 per cent., and some endeavor would undoubtedly be made to decrease time of chucking. There is a large amount of literature on the subject of these high speed steels, and some of the showings are little short of marvelous compared with former practice. This is especially the case under favorable conditions in experimental demonstrations. Under ordinary conditions the results are less startling, for the problem is not one of speed alone. High speed steel may not always be a paying investment; for example, a light job requiring relatively little time for cutting compared to time required for preparing and chucking; or, again, suppose under ordinary conditions, a man has all he can do attending to two machines, the cutting time of one being just sufficient for the chucking time on the other, then any decrease in cutting time would be of small advantage. In general, the new steels cannot be used to the limit, first, because the present machines will not stand it and the general tendency is to retain present tools, working them to the limit instead of at once scrapping them, and, second, much of the work will not stand it on account of special shapes. The old carbon steels give better results, as far as service is concerned, on very light finishing cuts. But on the larger work, shafting, guns, wheel turning, big planing operations, etc., the advantage is enormous. These steels have increased the output of railroad shop machines 25 to 100 per cent., and in some cases even 200 per cent."

Mr. Campbell discusses very fully the

subject of electric driving, and believes that owing to the specialization of motors the multi-voltage system of speed control may be replaced by the use of field controlled motors. He is distinctly in favor of individual motor driving as opposed to the group system, and gives practical data to show that the advantage of economy does not necessarily lie with the latter method.

The paper contains an excellent description of the electric power system at the shops of the Pittsburgh and Lake Erie shops at McKees Rocks, near Pittsburgh, with tabulated results of cutting speeds of lathes, planers, and other tools, on cast iron, steel, wrought iron, and brass, with data concerning the general output of the works.

MARINE GAS ENGINES.

APPLICATIONS OF INTERNAL-COMBUSTION MOTORS TO THE PROPULSION OF BOATS IN COMMERCIAL SERVICE.

C. Stein—Verein Deutscher Ingenieure.

WITH the general development of the large gas engine there has come a natural tendency to apply it as a motor to nearly every variety of machinery demanding the effort of mechanical energy. It is to be expected, therefore, that the combustion motor, in more than one type, should be applied to the propulsion of boats; not only for driving the small, high-speed pleasure craft, but also vessels of larger size and less pretensions as to speed.

An article by Herr C. Stein in recent issues of the *Zeitschrift des Vereines Deutscher Ingenieure* reviews the practical applications which have been made of gas engines for propelling commercial vessels, and although the subject is in an early stage of its career it already demands attention and review.

The earliest attempts to use internal-combustion motors for marine service involved the carrying of compressed illuminating gas, a freight boat called *L'Idée* having been so equipped to run between Havre, Rouen, and Paris in 1895. The gas was compressed to 100 atmospheres, there being 80 tanks, each holding 22 cubic metres of gas, the total volume of gas carried being 1,800 cubic metres. The 40 horse power engine consumed 450 litres of gas per horse-power per hour; giving a speed of 10 kilometres per hour, for 100 hours, or a radius of action of 1,000 kilometres. The gas tanks themselves weighed 26,000 kilogrammes, and Herr Stein computes that this weight, if replaced by a tank of petroleum, would supply fuel for 1,200 hours, or twelve times the period obtained with compressed gas.

By the use of modern benzine or gasoline motors the question of fuel is readily solved, and some very successful motors of this type have been made for marine use. All such motors involve certain modifications to be made in the propelling machinery in use for steam propulsion, and these points are very fully discussed in Herr Stein's paper. Thus the gas engine is not easily reversed, and should be operated regularly at its normal speed, the speed changes being controlled by other means than by varying the velocity of the engine.

Reversals are effected either by changing the angle of the propeller blades, or by the use of reverse gearing, changing the direction of revolution of the propeller shaft. The shifting propeller blades are not found to work well for larger powers than 100 horse power, although this method is satisfactory for small boats. Herr Stein illustrates several arrangements of clutches and gearing for reversing the propeller shaft, some of these being combined with a pivoted tail shaft, so that the propeller can be raised out of the water when proceeding under sail.

The use of gasoline motors for marine service is necessarily limited, and hence the practicability of employing producer gas becomes a matter for interest. The development of the suction gas producer offers opportunity for the arrangement of a complete power gas plant for such a service, and Herr Stein describes such an equipment on a freight boat navigating on the Elbe. This boat, the *Lotte*, is 41 metres long, 4.6 metres beam, drawing 2 metres with a load of about 240 tons. This boat is fitted with a pair of balanced gas engines,

the cylinders having the *vis-à-vis* arrangement, the suction gas producer being placed in an adjoining compartment, in order to protect the moving parts from the heat and dust. The engines develop about 100 horse power, this sufficing to propel the boat at a speed of about six kilometres per hour against the current. Experiments with this and other boats propelled by suction gas power show that the cost of transport falls as low as 0.64 pfennig per ton-kilometre, or about 0.25 cents per ton mile, as against 1 pfennig for steamboat transport, and 3.2 pfennigs on the railway.

The suction producer is especially applicable for use on shipboard, since an unlimited supply of water is available for condensing the impurities, tar, and other volatile matter in the gas, and there is also ample opportunity for keeping the cylinders of the motors properly cooled. In general the conditions for operating the internal-combustion motor are far more favorable on shipboard than on road vehicles. The question of weight is not of such controlling importance, and hence the various parts may be made of ample strength. The difficulties from dust and dirt are absent, while the working parts may be made readily accessible. At the present time the larger sizes of gas engines have not been applied to marine propulsion, but for the propelling of boats of moderate size at the speeds common for ordinary river transport the engines now available have already proved their capability and high economy.

The Diesel motor has also been applied to marine propulsion, and it has the especial advantage of using heavy oil, petroleum, and similar fuels directly in the cylinder, without requiring any carburetter. The high thermal efficiency of the Diesel motor naturally renders it especially desirable for vessels in which the radius of action is extended in proportion to the efficiency with which the fuel is converted into mechanical power.

Gas-engine propulsion for boats may be said to be yet in its infancy, but the results thus far attained have been most encouraging, and there is every reason to believe that the use of internal-combustion motors on shipboard will become widely extended.

TECHNICAL EDUCATION

PRACTICAL RESULTS FROM THE APPLICATION OF TECHNICAL EDUCATION TO ENGINEERING WORK.

John Goodman—Manchester Association of Engineers.

THERE is no longer much doubt in the minds of practical men in either Europe or America as to the real value of a technical training, although some men are disposed to believe that its advantages have been overrated. The whole subject is discussed in a very illuminating manner in a paper recently read by Professor Goodman before the Manchester Association of Engineers, and some abstract of this address will be found of much interest.

Taking up first the subject of the scope of technical education, it is shown to involve the systematic classification and use of facts.

"Sometimes our facts are meagre and only cover a narrow range of phenomena, and the conditions are highly complex, which thus prevents us at the outset from doing much classification, or even tracing the connection between our observed phenomena and the first principles of our science; therefore, as a first approximation, we have to be content with an imperfect law or statement known as an empirical formula. Such a proceeding is not strictly scientific, and if such a formula be applied to conditions outside those covered by the limited range of facts on which it is based it may lead to serious blunders: many of the discrepancies between theory and practice can be traced to such an improper use of empirical formulas.

"When our law or formula covers a very wide range of observed phenomena and rests moreover on the fundamental principles of science, whose truth has been abundantly established, the formula is known as a rational formula, and the process of obtaining and using such a formula comes within the category of scientific treatment. The scientific treatment of a

subject therefore amounts to the bringing of a concentrated experience to bear on the matter under consideration.

"Before a rigid scientific treatment is possible, the question under consideration must be cleared of all side issues and must be reduced to its simplest form; any conditions which tend in any way to hide the main point at issue are liable to be productive of errors. In laboratory experiments, naked or fundamental conditions can usually be arranged and the results be rigidly stated, but in practice side issues are often of great importance; errors of judgment then enter into the problem and may bring about discrepancies between the imperfect theory and practice. Those who most severely criticise the existence of these discrepancies are usually those who know least of the difficulties to be encountered.

"A technically educated engineer is keenly alive to the importance of side issues, and is constantly on the alert in making observations, collecting and classifying all data that will enable him in the future to adjust his formulas to fit practical conditions. Once having acquired the scientific mental attitude he will ever be athirst for knowledge and for data to throw light on the problems that confront him: it is this mental attitude that technical teachers aim at imparting to students.

"Those therefore who have acquired this attitude, gain experience much more rapidly than those who have not had the advantage of a technical training. This capacity for rapidly gaining experience is believed to be the most important result of technical education; in short, it teaches students to *observe* as well as *see*.

Professor Goodman takes such data as are available and plots curves showing the average income earned by engineers having a technical training, as compared with those without a technical education. A comparison of the two curves shows that while the man without the technical training first takes the lead, doubtless owing to his earlier start, he is soon overtaken and rapidly distanced by his better educated rival. In this respect the diagrams drawn by Professor Goodman resemble very closely those of a similar nature prepared a few years ago by Mr. James M. Dodge in a paper presented before the American Society of Mechanical Engineers, and it is an interesting confirmation of Mr. Dodge's conclusions to find them so fully borne out by data from an entirely different and independent source.

"It is a matter of common knowledge that there are many shrewd practical men who will not employ men of high technical attainments. They openly state that they prefer draughtsmen and managers who have very little, if any, scientific knowledge of engineering. This attitude is partly due to prejudice and partly to the fact that technically educated men often make themselves unpopular for one or more of the following reasons: They suffer from swelled heads and are very apt to compare their academic knowledge and methods with those of their employer or senior in the profession to the disparagement of the latter. They forget that his theoretical knowledge has probably got rusty through giving attention to other but equally important work for many years. Even if their seniors have never been possessed of such knowledge they are nevertheless entitled to the highest respect in virtue of other knowledge they possess of which the conceited youngster straight from college knows nothing. The college trained youth seems to forget too that the nomenclature of science to-day is very different from that in vogue a generation ago when their seniors were trained; hence many of the older engineers may have a very intimate knowledge of the theoretical side of engineering and yet know but little of the scientific technical terms used at the present day. The technical knowledge possessed by the raw student may not be in such a form as to be of much or of any service to him in actual engineering work. One occasionally meets highly mathematical men who lack all sense of proportion as regards the accuracy required for every-day purposes. They prefer a long, but apparently exact, mathematical treatment to a short cut which is sufficiently accurate for all practical purposes. Such men give one the impression that they would rather have a tooth drawn than make use of a convenient approximation."

Many of the defects of technical training are doubtless due to the work of teachers who have no real practical knowledge of

their subjects. By an insufficiency of business knowledge, and an unfamiliarity with actual methods employed in the workshop and field they leave essentials untaught, and the student must supply the deficiencies of such training by his own later experience. The best remedy for this state of affairs is one which has been applied with success in the United States, that is, by permitting, and even encouraging the professor to undertake outside work, and thus keep himself in touch with current practice. The plan of having eminent engineers as special lecturers is also an excellent method of bringing the actual working conditions of engineering practice before the students.

"Technical education is largely responsible for the improved position that engineering now occupies. For a long time it was regarded as a mere mercantile pursuit; then science was brought to bear upon the work of the engineer, and engineering now occupies the position of a learned profession whose exacting demands are fully recognised.

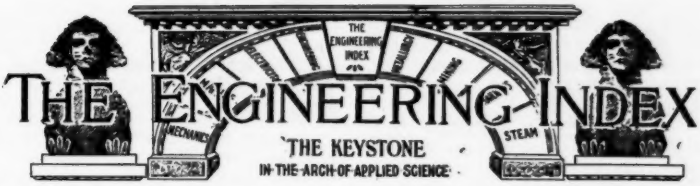
"Technical education has enabled gigantic engineering schemes to be successfully carried through which would have been quite impossible under the old rule of thumb régime. As a notable example we may cite the Forth Bridge.

"Technical education has done much towards reducing the cost of production. The cost of designing is less because the design is arrived at by a direct process which is necessarily quicker than the old trial and error method. The cost of material is less, because more suitable materials are now procurable (thanks to the scientific metallurgists) and because there is less waste, the exact amount required in each case being arrived at by calculation. The cost of manufacture is reduced, due to improved lifting appliances, to better machine tools, and to high speed steel, all of which owe their existence directly or indirectly to technical knowledge.

"Technical education enables the designer to turn out novel and improved designs. Some branches of technical education, of little value in themselves, are invaluable as aids to training the imagination—the very root of novelty in design.

"Technical education has the effect of rapidly developing and maturing inventions, a point sometimes of the highest importance, not only to the trade and profession of engineering, but also to the country itself. If a comparison be drawn between the development of the reciprocating steam engine and that of the steam turbine we find that for nearly two centuries the steam engine made practically no progress in the hands of men who had no pretence to a knowledge of science, whereas it progressed by leaps and bounds under the scientific treatment of Watt, Hirn, and others, who were pioneers in the application of thermodynamics to the steam engine. In the case of the steam turbine however, scarcely a quarter of a century has elapsed since that highly scientific and brilliant engineer Mr. Parsons invented a practical form of this machine, and to-day we have it as near perfect as it is every likely to be. We think we are justified in expressing this opinion, since the steam consumption of a turbine closely approaches the minimum possible in a theoretically perfect steam engine. Even the most bigoted of practical men will not pretend for one moment that the enormous difficulties encountered in the development of the steam turbine could ever have been surmounted without the aid of science, and we may go so far as to say that no firm can even follow in Mr. Parsons's footsteps and manufacture a satisfactory turbine to-day without the aid of scientific men in the form of draughtsmen or managers.

"To take another instance—the development of the internal combustion engine, which many far-seeing men believe will in the near future supplant the steam engine. Its birth as a practical machine is well within the memory of many of us, although many experimenters, groping in the dark, had previously dabbled with it; the problem was not solved until a highly trained doctor of philosophy in Germany took the matter in hand and from a noisy, troublesome, uncertain toy produced one of the most useful and efficient heat motors known. But great as was Dr. Otto's work, still greater perhaps was that of Diesel, who, from a purely theoretical standpoint attacked afresh the problem of the internal combustion engine and at one sweep nearly doubled its heat efficiency, or in other words nearly halved its fuel consumption.



The following pages form a **descriptive** index to the important articles of permanent value published currently in about two hundred of the leading engineering journals of the world—in English, French, German, Dutch, Italian, and Spanish, together with the published transactions of important engineering societies in the principal countries. It will be observed that each index note gives the following essential information about every publication:

(1) The title of each article,
(2) The name of its author,
(3) A descriptive abstract,
(4) Its length in words,
(5) Where published,
(6) When published,

(7) *We supply the articles themselves, if desired.*

The Index is conveniently classified into the larger divisions of engineering science, to the end that the busy engineer, superintendent or works manager may quickly turn to what concerns himself and his special branches of work. By this means it is possible within a few minutes' time each month to learn promptly of every important article, published anywhere in the world, upon the subjects claiming one's special interest.

The full text of every article referred to in the Index, together with all illustrations, can usually be supplied by us. See the "Explanatory Note" at the end, where also the full titles of the principal journals indexed are given.

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CIVIL ENGINEERING

BRIDGES.

Arches.

Computations for a Masonry Arch (Sur le Calcul d'Une Arche en Maçonnerie). M. Auric. Deriving equations for the ready calculations of the stresses in an arch of cycloidal curve. 800 w. Comptes Rendus—Oct. 16, 1905. No. 73325 D.

Masonry Arch of 90 Metres Span (Pont en Maçonnerie de 90 Mètres d'Ouverture). A. Bidault des Chaumes. An illustrated description of the great arch at Plauen, in Saxony, comparing it with the Luxembourg arch. 2000 w. 1 plate. Génie Civil—Nov. 4, 1905. No. 73316 D.

Parabolic Concrete Arch Bridge Over Piney Creek at 16th St., Washington, D. C. Illustrated detailed description of a bridge of unusual type. The arch ring has the curve of a parabola and a clear span of 125 ft. 3000 w. Eng News—Nov. 16, 1905. No. 73219.

We supply copies of these articles. See page 637.

The Plauen Viaduct. An illustrated description of this viaduct, the arch ring having the largest constructive span ever built in stone. 1700 w. Engr, Lond—Oct. 27, 1905. No. 73011 A.

Bengal.

The Damodar Coal-line Bridge: Midnapur-Jherria Extension of the Bengal-Nagpur Railway. William Oswald Taylor. Illustrated detailed description of the construction of a bridge consisting of 5 spans of 150-foot, one span of 100-foot, and one span of 40-foot steel girders, for a single line of rails, on masonry piers. 4200 w. Ills. (No. 3512.) Inst of Civ Engrs. No. 73182 N.

Floors.

Proposed Concrete Floors for Railway Bridges and Tracks. J. W. Schaub. Illustrates and describes a proposed design in which the track rests on a longitudinal timber bolted to a concrete floor. 1000 w. Eng News—Nov. 2, 1905. No. 72959.

Lattice-Girder.

The Determination of the Stresses in Lattice-Girder Bridges when Subjected to Concentrated Travelling-Loads, and the Effect of Replacing These Loads by "Equivalent Loads." Frederick Charles Lea. Discusses a simple but accurate method of determining these stresses, considering a number of special cases. Ills. 8200 w. (No. 3539.) Inst of Civ Engrs. No. 73172 N.

London Bridge.

The Widening of London Bridge. William Bartholomew Cole. Reviews the various movements for widening this bridge, which was opened in 1831, and the final work of widening the footways. Ills. 8500 w. (No. 3518.) Inst of Civ Engrs. No. 73171 N.

New York.

Williamsburg Bridge, New York. Frank W. Skinner. Illustrated description of this bridge and its construction, explaining the location and conditions and briefly describing the companion bridges. 6000 w. Engng—Oct. 18, 1905. Serial. 1st part. No. 73007 A.

Poughkeepsie.

Reinforcing the Poughkeepsie Bridge. Describes the high-level, double-track deck structure across the Hudson River, completed about 20 years ago, and the improvements to be made to meet present requirements. 1700 w. Eng Rec—Oct. 28, 1905. No. 72906.

Reinforced Concrete.

Reinforced - Concrete Bridges with Gravel Roadway (Betoneisenbrücken für Beschotterte Strassen). Anton Kraupa. Illustrating arrangements of structural beams imbedded in concrete and carrying highways. Computations for various loadings are given. 2000 w. Oesterr Wochenschr f d Oeffent Baudienst—Oct. 28, 1905. No. 73365 D.

Suspension.

Chains vs. Cables in the Manhattan Bridge. Wilhelm Hildenbrand. A letter giving arguments and explanation of the calculations on which the writer based his views. Also editorial. 3500 w. Sci Am—Nov. 4, 1905. No. 72967.

The Design of the Post Base of the Manhattan Bridge Towers. Gives an illustrated description of the tower post of this suspension bridge across the East River, New York, designed for very heavy loads. 2000 w. Eng Rec—Nov. 25, 1905. No. 73497.

Viaducts.

On the Construction of a Concrete Railway-Viaduct. Arthur Wood-Hill, and Edward Davy Pain. An illustrated detailed account of the construction of a concrete viaduct at Cannington, Eng., consisting of 10 elliptical arches, the total length being 600 ft. Ills. Discussion, and correspondence. 23000 w. (No. 3502.) Inst of Civ Engrs. No. 73150 N.

The Fades Viaduct. E. Ommelange. Illustrated detailed description of this viaduct under construction in France, which will be the highest railroad bridge in the world. 1000 w. R R Gaz—Vol. XXXIX., No. 21. No. 73432.

Zambesi.

The Opening of the Victoria Falls Bridge. Harold Shepstone. An illustrated account of the opening of this bridge over the Zambesi gorge in central Africa. 1000 w. Sci Am Sup—Nov. 4, 1905. No. 72969.

CONSTRUCTION.

Alterations.

Steel Details in the Alterations of the Judge Building. Brief illustrated description of extensive improvements carried out without disturbing the tenants of the building. The building was raised four additional stories, and a heavy interior wall which carried the ends of the floor beams was removed. 1000 w. Eng Rec —Nov. 11, 1905. No. 73143.

Building Construction.

The New Altman Building, New York. Describes the construction of this fine department store at 5th Ave., 34th and 35th Sts., giving details of the steelwork. 1200 w. Eng Rec—Nov. 4, 1905. No. 73063.

Building Details.

Structural Details in a Maiden Lane Building. Illustrates and describes details of a steel-cage building, eleven stories

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and basement, in New York. 1600 w. Eng Rec—Nov. 18, 1905. No. 73254.

Excavator.

A Submarine Rock Excavator. Charles Graham Hepburn. Describes an apparatus, designed and built in New South Wales, for the purpose of wharf-building and operations on submarine rock. Ills. 1000 w. (No. 3469.) Inst of Civ Engrs. No. 73165 N.

Foundations.

Corrugated Concrete Foundation Piles. Describes briefly the method adopted for foundations of the Lattemann Building, Brooklyn, intended for use as a shoe factory. 1000 w. Eng Rec—Nov. 11, 1905. No. 73142.

Sinking a Foundation Caisson with Post-Hole Augers. Illustrated description of unusual construction at the General Electric Co.'s works at Schenectady, to build engine foundations in quicksand. 600 w. Eng Rec—Nov. 18, 1905. No. 73249.

Sinking Machinery Foundations in Quicksand Without Excavation. Describes an ingenious and novel method of constructing foundations for a 60-ft. boring mill at the General Electric Co.'s plant, at Schenectady. 1000 w. Eng Rec—Nov. 4, 1905. No. 73065.

Unusual Foundations at the Hoboken Terminal of the Lackawanna R. R. Outlines conditions and gives an illustrated detailed description of the foundation work. 2000 w. Eng Rec—Nov. 11, 1905. No. 73141.

Naval Station.

Structural Features of the New Buildings at the New Orleans Naval Station. L. F. Bellinger. Illustrations with brief description. 700 w. Eng Rec—Oct. 28, 1905. No. 72909.

Reconstruction.

Reconstruction of the Mercantile Building, New York City. Illustrates and describes the methods used in adding six more stories, and building a steel-cage addition on the East Side. 3300 w. Eng Rec—Oct. 28, 1905. No. 72910.

Reinforced Concrete.

A Reinforced Concrete School Building. Illustrates and describes a very beautiful private school building in New York. 1400 w. Archts' & Bldrs' Mag—Nov., 1905. No. 73261 C.

Reinforced Concrete Building, for the Park Square Motor Mart, Boston. G. H. Brager. Illustrated description of a building under construction for the storage of motor vehicles. 1800 w. Eng Rec—Nov. 18, 1905. No. 73251.

Revetment.

Concrete Revetment for a 200-Foot Cliff, Niagara River Gorge, Niagara Falls, N. Y. Illustrated description of a revetment being built for the rock cliff. 500 w. Eng News—Nov. 2, 1905. No. 72960.

Tunnels.

I. Alfreton Second Tunnel. Ernest Frederick Crosbie Trench. (No. 3380.) II. The Reconstruction of Moncreiffe Tunnel. Dugald McLellan. (No. 3498.) With an abstract of the discussion on the two papers. Illustrated descriptions of the construction work. 22500 w. Inst of Civ Engrs. No. 73155 N.

Timber Tunneling in Quicksand. Rufus K. Porter. Describes in detail the method employed in constructing a sewer in the city of Newton, Mass., 500 ft. of which was built in timbered tunnels. Also general discussion. 5500 w. Jour Assn of Engng Soc's—Aug., 1905. No. 73029 C.

Tunnel Boring in Ancient Palestine. Brief account of tunnels built 2,500 years ago by means of which water was brought to ancient cities. 600 w. Sci Am—Nov. 4, 1905. No. 72965.

Underpinning.

Transferring a 2,000-Ton Wall to Columns and Girders. Illustrated description of a method of underpinning used for a heavy wall. 1200 w. Eng Rec—Nov. 4, 1905. No. 73064.

MATERIALS OF CONSTRUCTION.

Cement.

A Comparison of the Recent British and American Specifications for Cement. R. W. Lesley. Abstract of a paper read before the Am. Soc. for Test. Materials. 1300 w. Eng News—Nov. 16, 1905. No. 73223.

Compression.

Some Experiments for Determining the Elastic and Ultimate Strength of Brickwork Piers and Pillars of Portland-Cement Concrete. William Charles Popplewell. Describes tests carried out and gives conclusions. 3800 w. (No. 3549.) Inst of Civ Engrs—No. 73169 N.

The Compressive Resistance of Blocks and Columns of Concrete and Stone. Describes tests made which show the importance of considering the lateral and tensile stresses as well as the compressive force. Ills. 2400 w. Cement—Nov., 1905. No. 73109 C.

Concrete.

German Specifications for Designing, Constructing and Testing Concrete Structures. Leon S. Moisseiff. Gives the full set of specifications recommended for adoption by a committee of the German Concrete Society. 4500 w. Eng News—Nov. 9, 1905. No. 73080.

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Some Remarkable Tests Indicating "Flow" of Concrete Under Pressure. Ira H. Woolson. Illustrated account of some rather extraordinary results obtained in the Columbia Univ. Test. Laboratory. 600 w. Eng News—Nov. 2, 1905. No. 72958.

Concrete Blocks.

Concrete Block Construction and the Architects. Editorial discussion of this material, the shortcomings of the block maker, and the neglect of the architect. 1700 w. Eng News—Nov. 23, 1905. No. 73425.

The Manufacture of Concrete Blocks and Their Use in Building Construction. H. G. Richey. Third prize paper. Considers points of importance in the manufacture and construction. Ills. 7000 w. Cement Age—Nov., 1905. No. 73266.

Fire Tests.

Fire Tests with Concrete and Reinforced Concrete. An account of the fire and water tests conducted by the British Fire-Prevention Committee. 1800 w. Engng—Nov. 17, 1905. No. 73482 A.

Reinforced Concrete.

Breaking Tests of Reinforced Concrete Structures. Illustrated report of tests made of various structures at the exhibition of the German Municipalities at Dresden, at the time of their removal. 3000 w. Cement—Nov., 1905. No. 73108 C.

Reinforced Concrete Applied to Modern Shop Construction. E. N. Hunting. States the advantages of this material, showing how well it is adapted to shop construction; also gives some data on actual work of this class. Ills. 1800 w. Trans Am Soc of Mech Engrs (No. 083)—Dec., 1905. No. 73439 C.

Shearing.

Shearing Forces Due to a Uniform Advancing Load on Beams and Braced Girders. Prof. W. E. Lilly. A solution of the maximum shearing stresses in the bracing of girders under a uniform advancing load equal in length to the span. 500 w. Engng—Nov. 10, 1905. No. 73286 A.

Sheet Piling.

American Steel Sheet Piling. Illustrated descriptions of a number of designs used for cofferdams, mine shafts, wells for foundation piers, and general foundation work. 1100 w. Engr, Lond—Nov. 3, 1905. No. 73136 A.

Steel Sheet Piling. Describes recent work where this material has been used. 1700 w. Eng News—Nov. 23, 1905. No. 73423.

Timber.

The Inspection of Treatment for the Protection of Timber by the Injection of Creosote Oil. H. R. Stanford. Treats only of the quantity of oil which is injected, and is based on tests and observations made upon yellow pine treated for use in engineering structures in Pensacola Bay. 2500 w. Pro Am Soc of Civ Engrs—Nov., 1905. No. 73437 E.

MEASUREMENT.

Earthwork.

The Determination of Profiles in Excavation and Embankment Work of Trapezoidal Section (Beitrag zur Konstruktion des Flächenprofiles bei Trassierung von Verkehrswegen mit Trapezoidischem Querprofile des Kunstkörpers). Karl Allitsch. Deriving a graphical method, with table to facilitate the work. 2000 w. Oesterr Wochenschr f d Oeffent Baudienst—Nov. 4, 1905. No. 73366 B.

Surveying.

Meridian Diagrams. Charles Arthur Albert Barnes. Describes certain practical methods which have proved satisfactory. 1700 w. (No. 3531.) Inst of Civ Engrs. No. 73173 N.

Methods of Rod-Holding in Stadia Surveying and Description of a New Stadia Slide Rule. Arthur L. Bell. Describes the two methods of rod or staff holding now in use, and the circular slide rule for reducing stadia readings designed by the writer. Ills. 2500 w. Eng News—Nov. 9, 1905. No. 73082.

MUNICIPAL.

Curbs.

Suggestions Covering Combined Curb and Gutter. Albert Moyer. Gives outlines for specifications for the manufacture of monolithic cement stone. 1800 w. Eng Rec—Nov. 4, 1905. No. 73060.

Destructor.

The Combined Rubbish Destructor and Power Plant in New York. An illustrated detailed description of the Williamsburg bridge plant, its equipment and operation. 4000 w. Eng Rec—Nov. 11, 1905. No. 73139.

Sewage Disposal.

Progress in the Work of Turning Chicago's Sewage Away from Lake Michigan. Editorial review of the present situation, and the work in progress on the intercepting sewer system 1400 w. Eng News—Nov. 9, 1905. No. 73084.

Reflections on Sewage Farming Suggested by Experiences at Reading, England. Editorial on sewage treatment and a review of a report on the operation of the Reading sewage farm. 3000 w. Eng News—Nov. 16, 1905. No. 73222.

The Operation of the Sewage Works of Manchester, England, 1904-5. A report of the operation of remodelled sewage works. 1700 w. Eng News—Nov. 2, 1905. No. 72964.

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The Tankage of Sewage. F. Wallis Stoddart. Read before the Roy. Inst. of Pub. Health. A discussion of sewage treatment, describing experiments showing the effect of rate of flow, tank capacity, &c. 4200 w. Eng Rec—Nov. 18, 1905. No. 73252.

Sewage Pumping.

Notes on the Working of the Shone System of Sewerage at Karachi. James Forrest Brunton. An account of trials, made with a view to ascertain the cause of the unsatisfactory working of the installation, with the results. 3300 w. Tables and diagrams. (No. 3436.) Inst of Civ Engrs. No. 73148 N.

The Sewage Pumping Station at the Hampton Institute. An illustrated detailed description of a sewerage system designed to serve about 1,000 people, living and working in separate buildings over a considerable area. 2500 w. Eng Rec—Nov. 18, 1905. No. 73248.

The Thirty-Ninth Street Sewage Pumping Station, Chicago. Illustrated detailed description of a station having a rated capacity of 900,000 gal. a minute. 4500 w. Eng Rec—Nov. 18, 1905. No. 73253.

Sewers.

Breakage in Sewer Pipes. Information from a paper by Mr. Alexander Potter, of New York, read before the Boston Society of Civil Engineers. 1600 w. Eng Rec—Oct. 28, 1905. No. 72907.

The Broadway Outfall Sewer, Borough of the Bronx, New York. Illustrates and describes the twin sewer built to carry the combined sewage and storm water flow from the watershed of Tibbitt's Brook. Describes the construction. 2500 w. Eng Rec—Nov. 11, 1905. No. 73144.

The Sewerage of Douglas, Isle of Man. Edmund Herbert Stevenson, and Edward Knaston Burstal. A brief history ot the sewerage of Douglas, with a description of the existing system recently carried out by the authors. Discussion. Ills. 14000 w. (No. 3510.) Inst of Civ Engrs. No. 73149 N.

Vitrified Tile Sewers as House Drains in Chicago. Perry L. Hedrick. States the conditions in Chicago, quoting from plumbing ordinances, and showing that a careful workman can lay a tile sewer so as to make it water tight and to withstand the specified pressure. 2000 w. Eng News—Nov. 2, 1905. No. 72957.

Sunlight.

The Orientation of Buildings and of Streets in Relation to Sunlight. William Atkinson. A study of the subject in relation especially to hospital architecture, but applicable to residences. Ills. 5700 w. Tech Qr—Sept., 1905. No. 73028 E.

WATER SUPPLY.

Artesian.

The Artesian System of Western Queensland. Cyrus John Richard Williams. Information concerning the water-bearing beds, the flowing and non-flowing wells, and related matter of interest. 1500 w. (No. 3490.) Inst of Civ Engrs. No. 73174 N.

Farm Supply.

Water Supply for Farm Buildings. An illustrated description of work and an account of how it was secured and erected. 1500 w. Met Work—Nov. 18, 1905. No. 73208.

Filtration.

A Modern Filter Plant. Freeland Howe, Jr. Illustrates and describes the installation of mechanical filters at Danville, Va., giving details and results. 1200 w. Munic Engng—Nov., 1905. No. 72916 C.

Report of Board of Investigating Engineers on the Philadelphia Filtration and Boulevard Contracts. Gives full report of the committee appointed to investigate all matters relating to the work on the city's new filtration plant and boulevard system. 11000 w. Eng News—Nov. 2, 1905. No. 72962.

Ground Water.

The Flow of Water into Wells and Excavations (Ueber den Wasserzudrang in Brunnen und Baugruben). Dr. Philipp Forchheimer. An examination of the influence of pressure due to underground currents in connection with the filling of wells. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Oct. 27, 1905. No. 73329 D.

Intake.

An Old Wood Stave Water Intake at Quincy, Ill. Edward Prince. Illustrates and describes a pipe, laid in 1887, and still in perfect condition. 900 w. Eng News—Nov. 2, 1905. No. 72961.

Pipe Corrosion.

Guarding Against Electrolysis of Underground Pipes. Putnam A. Bates. Gives results of recent tests made in a large town near New York, to determine the condition with regard to the presence of leakage currents from the grounded circuit of the local traction company. 2000 w. Elec Rev, N Y—Nov. 11, 1905. No. 73114.

Pumping Plant.

The Turbine Pumping Plant of the Buffalo Water Works. An account of extensive improvements, including the installation of eight 25,000,000-gal. vertical two-stage turbine pumps, each connected to an electric motor. 1300 w. Eng Rec—Oct. 28, 1905. No. 72908.

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Pumps.

See Mechanical Engineering, Hydraulics.

Reservoirs.

Sheet Steel Piles in Reservoir Construction. Describes a reservoi· near New Milford, New Jersey, explaining the conditions. Ills. 1200 w. Eng Rec—Nov. 18, 1905. No. 73250.

The East Canyon Creek Reservoir, Morgan Co., Utah. William M. Bostaph. A brief history of this irrigation enterprise and an illustrateed description of the work. 3200 w. Eng Rec—Nov. 25, 1905. No. 73495.

Springs.

The Hot and Mineral Springs of Routt County and Middle Park, Colorado. A. Lakes. An illustrated description of interesting and valuable springs, which will probably become very important in the future. 1200 w. Min Rept—Nov. 2, 1905. No. 73041.

The Scherrer Method of Impounding Mineral Springs (Die A. Scherrersche Mineralquellen - Fassungsmethode). F. Müller. A review of methods of collecting any one of several sources of underground water, showing the practicability of capping the veins of water in the rock. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 3, 1905. No. 73330 D.

WATERWAYS AND HARBORS.

Canals.

The Bridgewater Canal Navigations. Walter Hartley Wiswall. Information concerning this 40 mile canal in England. 700 w. (No. 3504.) Inst of Civ Engrs. No. 73163 N.

Coast Erosion.

I. Coast Erosion. Alfred Edward Carey. (No. 3493.) II. Erosion on the Holderness Coast of Yorkshire. Ernest Romney Matthews. (No. 3495.) With an abstract of the discussion on the two papers. In the first paper the author considers from an administrative rather than from an engineering standpoint, the measures to be adopted for defence against such encroachment. The second paper describes the remedial works executed or suggested. Ills. 5400 w. Inst of Civ Engrs. No. 73154 N.

Docks.

The Graving Docks of Hong Kong. Albert Denison. Short descriptions of the docks built and under construction. 1000 w. (No. 3492.) Inst of Civ Engrs. No. 73166 N.

The New Bombay Docks. Information concerning the work in progress for increasing the dock facilities, and some of the difficulties to be overcome. 2500 w. Engr, Lond—Nov. 10, 1905. No. 73293 A.

Dredging.

Dredging and Dredging Appliances. Brysson Cunningham. The present article illustrates and describes types of dipper and ladder dredges. A concluding article will be devoted to grab and hydraulic dredges. 2500 w. Cassier's Mag—Nov., 1905. Serial. 1st part. No. 72990 B.

Government Dredge for Delaware River. Illustrated detailed description. 1200 w. Marine Engng—Nov., 1905. No. 72914 C.

Harbor Works.

Seaham Harbor New Works. Illustrates and describes the important engineering works, recently completed, for the improvement of this harbor and docks. 1600 w. Engr, Lond—Nov. 10, 1905. No. 73298 A.

Hooghly.

The River Hooghly. Leveson Francis Vernon-Harcourt. An account of this very interesting branch of the Ganges, founded upon very careful investigations, and a study of all the available charts. Ills. 41500 w. (No. 3478). Inst of Civ Engrs. No. 73151 N.

New South Wales.

Improvements at the Entrance to the Richmond River, New South Wales. Thomas Edward Burrows. Gives an account of the works carried out or in course of construction, in accordance with the recommendations of the late Sir John Coode. 5400 w. Ills. (No. 3503.) Inst of Civ Engrs. No. 73180 N.

Niagara.

The American and Canadian Channels of Niagara Falls. Alton D. Adams. An illustrated description of the two channels with remarks on the effect of further diversions of water above the falls. 2000 w. Elec Rev, N Y—Nov. 11, 1905. No. 73115.

Orinoco.

The Orinoco—A Wasted Waterway. G. L. M. Brown. Illustrated description of this remarkable river, its peculiarities, the vessels that navigate it, &c. 2200 w. Sci Am—Nov. 25, 1905. No. 73415.

Overflow.

The Levee and Drainage Problem of the American Bottoms. Edwin G. Helm. Discusses the protection from overflow of the Mississippi River and the drainage of the interior waters of the American Bottoms. 11700 w. Jour Assn of Engng Socs—Sept., 1905. No. 73484 C.

Panama.

An Engineer's Life in the Field on the Isthmus. Fullerton L. Waldo. A well illustrated account from actual experience on the canal work; together with a hitherto unpublished report on the Gamboa

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Dam. 6000 w. Engineering Magazine—Dec., 1905. No. 73372 B.

Progress on the Panama Canal Work. Information from the address of Hon. William H. Taft, before the St. Louis Commercial Club. Especially concerning the troubles and difficulties experienced during the last two years. 7200 w. Eng News—Nov. 23, 1905. No. 73424.

The Panama Contretemps. Editorial discussion of the present situation. 1800 w. R R Gaz—Vol. XXXIX., No. 21. No. 73430.

The Panama Water and Sewerage Works. An illustrated article describing the condition of the City of Panama before the treaty with the United States, and the work that has been done since in the water supply and sewerage departments. 2000 w. Eng Rec—Nov. 25, 1905. No. 73493.

The Real Conditions at Panama. Eugene P. Lyle, Jr. The second of a series of investigations of the problems involved in the control of the canal. 6800 w. World's Work—Nov., 1905. No. 72923 C.

What Has Been Accomplished at Panama. Theodore P. Shonts. Extracts from an address before the Am. Hardware Mfrs.' Assn. Discusses the sanitation of the Isthmus, and the providing of suitable habitations for all classes of employees, and the food supply. The difficulties to be overcome are explained. 3000 w. Eng News—Nov. 16, 1905. No. 73220.

Water Flow.

See Mechanical Engng, Hydraulics.

ELECTRICAL ENGINEERING

COMMUNICATION.

Address.

Presidential Address to the Institution of Electrical Engineers. John Gavey. Principally a discussion of telegraphy and telephony, and their problems. 12800 w. Elect'n, Lond—Nov. 10, 17, 1905. Serial. 2 parts. No. 73459 each A.

Arizona.

Telephone Engineering in "The Country God Forgot." George Bond Ellison. An amusing account of difficult work in Arizona. Ills. 3500 w. Jour of Elec—Nov., 1905. No. 73068 C.

Coherers.

Theory of Coherer Action. From the *English Mechanic and World of Science.* Briefly discusses the theeories advanced by Lodge, Branly, Bose, and Dr. Guthe, especially the last named. Also the theory developed by Dr. Lee de Forest, and gives a description of two of the coherers used in wireless telegraphy. 4000 w. Sci Am Sup—Nov. 11, 1905. No. 73094.

Long Distance.

Long-Distance Telegraphy in Australia. T. Howard. An account of a trial of long-distance working over the Australian telegraph lines. 1000 w. Elec Rev, N Y—Nov. 25, 1905. No. 73471.

Space Telegraphy.

A Method of Testing Wireless Receivers. Greenleaf W. Pickard. Describes a method used by the writer. Diagram. 1000 w. Elec Wld & Engr—Nov. 25, 1905. No. 73469.

Earthed and Unearthed Radiators in Wireless Telegraphy. W. H. Eccles. A statement of the reasons and facts that have made the use of the earthed radiator almost universal and the use of one unearthed rather exceptional. 1800 w. Elect'n, Lond—Oct. 27, 1905. No. 73003 A.

The Strasburg Experiments upon Directed Wireless Telegraphy (Die Strassburger Versuche über Gerichtete Drahtlose Telegraphie). Dr. Ferdinand Braun. Describing the use of two sets of waves of very slight phase difference to enable the direction of the transmission to be controlled. 2000 w. Elektrotech u Polytech Rundschau—Nov. 1, 1905. No. 73362 D.

Telephony.

The Kellogg Common-Battery Telephone System. W. S. Henry. Illustrated description of this system as installed in Philadelphia. 1000 w. Am Elect'n—Nov., 1905. No. 73057.

The Use of the Telephone in Army and Navy Manœuvres. Col. B. K. Roberts. An account of the communications used during the recent Army and Navy exercises, to keep the officers informed as to the movements and approach of the Navy in its attack on the forts which defended the City of Washington. 1200 w. Elec Wld & Engr—Nov. 4, 1905. No. 73073.

Voice Overtones, or Harmonics, as Affecting Long-Distance Telephone Transmission. D. MacL. Therrell. Describes an apparatus and experiments for improving articulation. 4500 w. Elec Wld & Engr—Nov. 11, 1905. No. 73202.

DISTRIBUTION.

Controllers.

Magnetic Switch Controllers on Electrically Operated Automatic Ore Unload-

ers at Lorain, O. R. I. Wright. Gives a brief description of the control equipment, with illustrations of some typical elements of the equipment. The unloaders are of the Hulett type. 1200 w. Eng News—Nov. 9, 1905. No. 73081.

Earthing.

Tests for Earthing (Erdungsprüfer). Dr. M. Corsepius. Describing apparatus and methods for testing the completeness of earthing connections for machinery, lightning arresters, and other electrical appliances. 1800 w. Elektrotech Zeitschr —Oct. 19, 1905. No. 73349 B.

Fuses.

Zinc and Aluminium Fuses. Alfred Schwartz and W. H. N. James. An experimental examination of zinc and aluminium as materials for fusible cut-outs. 1200 w. Elec Rev, Lond—Nov. 17, 1905. Serial. 1st part. No. 73457 A.

Hamburg.

The Electric Distribution System of the City of Hamburg (Le Reseau de Distribution Electrique de la Ville de Hambourg). With plan of the city and plan and sections of the main generating station. 1500 w. 1 plate. Génie Civil—Oct. 21, 1905. No. 73311 D.

Hospital.

Electricity in the London Hospital. An illustrated description of the electric light and power installation, comprising about 6,000 lights and 100 motors. 5000 w. Elec Rev, Lond—Nov. 10, 1905. No. 73282 A.

Power Distribution.

Distribution of Electrical Energy. John Francis Cleverton Snell. Historical review of progress, and a discussion of the prospects of a wider commercial use of electrical energy. Discussion. Ills. 38000 w. (No. 3522.) Inst of Civ Engrs. No. 73152 N.

Electricity and Sewage Disposal. Illustrated description of the high tension power distribution scheme of the Birmingham Tame and Rea District Drainage Board to pump sewage to a higher level. It is also used to drive motors at various places, lighting, etc. 2300 w. Elec Engr, Lond—Nov. 17, 1905. No. 73455 A.

The Distribution of Electricity in Mines. Deals with the types of cable that should be used in the various situations and the most satisfactory methods of installing them. 1800 w. Elec Engr, Lond —Oct. 27, 1905. Serial. 1st part. No. 73001 A.

Transformers.

Switching System for the Reduction of Losses in Single and Polyphase Transformers when Operating Unloaded (Schaltungsanordnungen zur Vermeidung bezw. Verringerung der Leerlaufsarbeit bei Ein und Mehrphasen-Wechselstromtransformatoren). J. Schmidt. Describing hand operated and automatic switches for the cutting out of transformers. Two articles. 7500 w. Zeitschr f Elektrotechnik—Oct. 22, 29, 1905. No. 73356 each D.

The Multiple Operation of Transformers. R. T. MacKeen. Discusses the principles involved in the multiple operation of transformers, thus showing how to accomplish the best results. 2000 w. Can Elec News—Nov., 1905. No. 73207.

Warehouse.

The Technical Arrangement of the Oberpolliger Warehouse in Munich (Die Technischen Einrichtungen des Kaufhauses Oberpollinger in München). Julius Weil. Details of the sub-station converters, illumination, elevator service, etc., of a department store in Munich. Nernst lamps are extensively used. 4500 w. Elektrotech Zeitschr—Oct. 26, 1905. No. 73350 B.

Wiring.

Lead-Covered Wiring. John D. MacKenzie. Presents the advantages and disadvantages of this system, showing how some of the disadvantages may be minimized. 2000 w. Elec Rev, Lond—Nov. 10, 1905. No. 73281 A.

ELECTRO-CHEMISTRY.

Accumulators.

Accumulators without Lead Plates (Ueber Nichtbleiakkumulatoren). Dr. Karl Elbs. A discussion of the chemical reactions in storage batteries of the Edison and Jungner type, using an alkaline electrolyte and plates of other metals than lead. 1000 w. Zeitschr f Elektrochemie—Oct. 27, 1905. No 73360 G.

Accumulator without Lead Plates (Ueber Nichtbleiakkumulatoren). Dr. Gräfenberg. Discussing the operative conditions of the nickel-iron battery, giving curves, showing the discharging pressures. 1500 w. Zeitschr f Elektrochemie —Oct. 27, 1905. No. 73361 G.

Electric Storage Battery Engineering. J. Lester Woodbridge. Gives the points of difference between a dynamo and a storage battery, and discusses the character of the work the storage battery is best fitted to perform; also the characteristics of the storage battery and its auxiliary apparatus, its care, &c. 4500 w. Cassier's Mag—Nov., 1905. .No. 72991 B.

Electric Furnaces.

An Electrical Steel-Furnace. Gustave Gin. Abstract of a paper read at meeting of the Am. Elec-Chem. Soc. Gives plan

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and sections of furnace, with description. 1000 w. Eng & Min Jour—Nov. 11, 1905. No. 73106.

Electric Furnaces. J. H. Stansbie. Abstract of a paper read before the Birmingham (Eng.) Electric Club. Brief illustrated descriptions of some simple forms of electric furnaces which can be readily fitted up for experimental purposes. 1400 w. Elec Engr, Lond—Nov. 10, 1905. No. 73279 A.

The Gin Electric Furnaces (Fours Electriques Gustave Gin). G. Dary. Illustrated description of the electric furnaces for refining steel, and for producing vanadium and its alloys, as exhibited at Liége. 2500 w. L'Electricien—Nov. 11, 1905. No. 73364 B.

The Ruthenburg and Acheson Furnaces. F. A. J. FitzGerald. Describes the working and explains the theory of these furnaces. 2000 w. Elec-Chem & Met Ind—Nov., 1905. No. 73070 C.

Electrolysis.

Alternate-Current Electrolysis as Shown by Oscillograph Records. W. R. Cooper. Read before the Faraday Soc. Reviews briefly recent views on this subject, and gives a report of experimental investigations, giving records obtained by a double oscillograph. 1800 w. Elec Engr, Lond—Nov. 3, 1905. No. 73127 A.

Alternating-Current Electrolysis? S. M. Kintner. Illustrated description of a test made under as nearly service conditions as possible, showing the action to be very slight. 1000 w. Elec Jour—Nov., 1905. No. 73407.

Electrolysis with Alternating Currents (Elektrolyse mit Wechselstrom). Dr. Max Le Blanc. Discussing especially the action of alternating currents upon complex solutions. 2000 w. Zeitschr f Elektrochemie—Oct. 27, 1905. No. 73358 G.

The Electrolysis of Water. Joseph W. Richards. Divides the subject into its experimental, its theoretical, and its applied phases, treating each in detail. Ills. 5000 w. Jour Fr Inst—Nov., 1905. No. 73098 D.

ELECTRO-PHYSICS.

Atmospheric Electricity.

Telluric Currents. Reviews an article by M. Guarini to the Belgian Astronomical Society upon telluric currents, their origin, direction, their disadvantages and their possible utilization. 2400 w. Sci Am Sup—Nov. 18, 1905. No. 73206.

Hysteresis.

Comparative Investigations upon Linear and Rotary Magnetic Hysteresis (Vergleichende Untersuchungen über Lineare und Drehende Magnetische Hysteresis). Dr. W. Wecken. A review of previous work, with data and results of the author's investigations on steel and on wrought and cast iron. 4500 w. Zeitschr f Elektrotechnik—Nov. 5, 1905. No. 73357 B.

Radioactivity.

Induced Radioactivity Excited in Air at the Foot of Waterfalls. J. C. McLennan. Read before the Am. Phys. Soc. An account of experimental investigations made of Niagara Falls, describing apparatus, experiments, &c. 3800 w. Sci Am Sup—Nov. 4, 1905. No. 72970.

Waves.

Wave Shapes in Three-Phase Transformers. R. C. Clinker. A study of the wave distortion produced in star-connected three-phase transformers, as shown by use of the Hospitalier ondograph. Editorial. 2000 w. Elect'n, Lond—Nov. 10, 1905. No. 73283 A.

GENERATING STATIONS.

Accumulators.

See Electrical Engineering, Electrochemistry.

Coal Handling.

See Mechanical Engineering, Power and Transmission.

Dynamos.

How to Build a Small Alternating-Current Dynamo Without Castings. Nevil Monroe Hopkins. Illustrates and describes a machine which produces a single-phase alternating current of 110-volts pressure, and is built without patterns or castings. 5000 w. Sci Am Sup—Nov. 11, 1905. No. 73095.

Efficiency.

The Efficiency of Electrical Power Generating Stations. H. M. Hobart. A study of the net annual efficiency of electric supply stations. Also editorial. 3000 w. Elec Wld & Engr—Nov. 25, 1905. No. 73466.

Hydroelectric.

Hydroelectric Plant on the Spring River, Kansas. Illustrated description of an interesting plant supplying electric power to the lead and zinc fields of Missouri. 3500 w. Elec Rev, N Y—Nov. 18, 1905. No. 73257.

Les Clées-Yverdon Hydraulic Plant. C. L. Durant. An illustrated description of a system furnishing power for numerous applications of electric motors and in small industries, as well as for large shops and for lighting. 3500 w. Elec Rev, N Y—Nov. 25, 1905. No. 73470.

Niagara Power in the Gorge. An illustrated historical review of the development of power in the gorge, dating back to 1853. 3500 w. Elec Wld & Engr—Nov. 18, 1905. Serial. 1st part. No. 73244.

The Charmey Power Station (Usine de Charmey). A Hostache. An illustrated description of the hydro-electric plant at Charmey, supplying the district about Bulle, near Fribourg, Switzerland. 2000 w. Bull Tech de la Suisse Rom—Oct. 25, 1905. No. 73367 D.

The Hydraulic Plant of the Chattanooga & Tennessee River Power Co. Brief illustrated description of a plant for utilizing 56,000 h. p. of the energy of the Tennessee River, at Hales Bar, Tenn. 1200 w. Eng Rec—Nov. 4, 1905. No. 73062.

The Hydro-Electric Plant of the Spring River Power Co. Illustrated description of a plant for furnishing power to the zinc mines near Joplin, Mo. The plant shows novel features of interest. 4000 w. Engr, U S A—Nov. 1, 1905. No. 72951 C.

The Kaiserwerke Hydro-Electric Station in the Tyrolese Oberland (Die Ueberland Zentrale Kaiserwerke). H. Manasse. A very fully illustrated account of the utilization of the discharge of Hinteroteiner Lake in the Tyrol, near Kufstein. Serial. Part I. 3500 w. Elektrotech Zeitschr—Nov. 9, 1905. No. 73355 B.

The Niagara Power Plant of the Electrical Development Company of Ontario. Begins an illustrated detailed description of the design and structures. 3000 w. Eng News—Nov. 9, 1905. Serial. 1st part. No. 73079.

The Washoe Power and Development Company's Plant on the Truckee River. Wyatt H. Allen. Illustrated detailed description of a plant for supplying the towns of Reno and Sparka, Nevada, with electric power and the final union of four companies, forming the "Union Light & Water Co." 4500 w. Jour of Elec—Nov., 1905. No. 73067 C.

Instruction.

Instruction of Men Operating Interconnected High and Low-Tension Systems, with Reference to Safety of Employees, Reliability of Service, and Resumption of Same After Partial or Total Interruption. W. F. Wells. Abstract of a paper at meeting of the Assn. of Edison Ill. Cos. 2800 w. Elec Rev, N Y—Nov. 18, 1905. No. 73256.

Isolated Plant.

Power and Lighting Equipment of a Modern Hotel. Illustrates and describes the engineering features of the Gotham hotel, at Fifth Ave. and Fifty-fifth St., New York City. 2000 w. Am Elect'n—Nov., 1905. No. 73054.

Lackawanna Plant.

The Power System of the Lackawanna R. R. in Luzerne Co., Pa. H. M. Warren. Deals with the preliminary estimates, plans and details of the plant under construction in the Nanticoke district, near Scranton, with its substations and transmission lines. 3800 w. Eng Rec—Nov. 4, 1905. No. 73059.

The Power Plant for the New Wanamaker Store, Philadelphia. Illustrated description of a plant for a twelve-story department store, supplying electric power for lighting and motors, steam, compressed air, and water. It is located a block distant. 4500 w. Eng Rec—Oct. 28, 1905. No. 72905.

Testing.

See Electrical Engineering, Measurement.

Three-Phase.

Three-Phase Generating Set (Groupe Electrogène Triphasé). J. A. Montpellier. Illustrated description of a 600 horse power Rateau steam turbine connected to 400 kw. alternator by Sautter, Harlé & Co., exhibited at Liége. 2000 w. L'Electricien—Oct. 28, 1905. No. 73363 B.

LIGHTING.

Car Lighting.

Some Wiring Diagrams for Car Lighting. Cole Gough. Diagrams and descriptions of various wiring schemes. 500 w. St Ry Jour—Nov. 2, 1905. No. 73027 C.

Hotel Illumination.

The Illumination of the Hotel Astor, New York City. E. Leavenworth Elliott. An illustrated article describing some of the changes made which has made this one of the most successfully lighted of modern buildings of this class. 2500 w. Cent. Sta—Nov., 1905. No. 73110.

Photometry.

See Electrical Engineering, Measurement.

Reflector.

The Diffusing Reflector. E. L. Zalinski. Information, based on measurements, made chiefly at the Electrical Testing Laboratories, in regard to the use of a different coating in connection with a prismed reflector, showing that the more important gain is the better distribution obtained. 2500 w. Elec Rev, N Y—Nov. 4, 1905. No. 73023.

Tantalum.

Tantalum and the Tantalum Electric Lamp (Das Tantal und die Tantallampe). Dr. Werner von Bolton. Describing the properties of metallic tantalum, with a brief description of the Siemens & Halske incandescent lamp with tantalum filament. 1500 w. Zeitschr f Elektrochemie —Oct. 27, 1905. No. 73359 G.

Theatre Illumination.

Electric Equipment of a Buffalo Theatre. Describing the arrangement of footlights and border lights dimmers, and

switchboard for an equipment of more than 5,000 lamps; using a two-wire system. 1000 w. Elec Wld & Engr—Nov. 4, 1905. No. 73074.

MEASUREMENT.

Magnetization.

Measurement of the Specific Magnetization of Diamagnetic on Slightly Magnetic Bodies. Emile Guarini. Brief description of an apparatus designed by M. P. Curie and M. C. Cheneveau. 1000 w. Sci Am Sup—Nov. 11, 1905. No. 73096.

Meters.

Meters for Continuous Current, Single Phase, and Polyphase Currents, of the Aron Works at Charlottenburg (Umschaltzähler für Gleichstrom, Ein- und Mehrphasigen Wechselstrom der Elektrizitätszählerfabrik H. Aron in Charlottenburg). A report of tests made by the Reichsanstalt. 1000 w. Elektrotech Zeitschr—Oct. 19, 1905. No. 73348 B.

Photometry.

Reflectors, Shades and Globes. J. R. Cravath and V. R. Lansingh. A report of tests which give information on the photometric performance of common types. Ills. 2000 w. Elec Wld & Engr—Nov. 25, 1905. Serial. 1st part. No. 73467.

Some Tests on Lamp Globes. Maurice Solomon. A discussion of results obtained in the course of some experiments on the mean spherical candle-power and distribution of light with Nernst lamps. Also editorial. 3300 w. Elect'n, Lond—Nov. 3, 1905. No. 73129 A.

Standards.

The Regulations, Standards, and Specifications of the German Electrotechnical Association (Die Vorschriften, Normalien, und Leitsätze des Verbandes Deutscher Elektrotechniker). G. Dettmar. A general description, by the secretary of the association, of the electrical standards and working regulations relating to wiring and installation of machinery. 4000 w. Zeitschr d Ver Deutscher Ing—Oct. 21, 1905. No. 73302 D.

Testing.

A Small Motor Testing Equipment. Roy T. Wells. Describes an outfit for factory testing of small electric machines. 1000 w. Elec Wld & Engr—Nov. 25, 1905. No. 73468.

Commercial Testing of Electrical Machinery. The "Pump Back" Method. H. B. Foote. Describes the method of testing sets of machines by what is known as the "pump back" or "loss supply" method. Diagrams. 1000 w. Sib Jour of Engng—Oct., 1905. No. 73488 C.

MOTORS.

Classification.

Electric Motors and Their Applications. W. Edgar Reed. Gives a classification according to their speed-torque characteristics, and a statement regarding their other important operating characteristics, which are useful in making applications. Discussion. Ills. 6400 w. Pro Engrs' Soc of W Penn—Oct., 1905. No. 72980 D.

Induction Motors.

Notes on Alternate-Current Induction Motors. T. Harding Churton. Compares the performance and characteristics of motors provided with short-circuit and with wound rotors respectively; the performances of such motors on single-phase and polyphase circuits; and indicates the effect of frequency of alternations on the working of such motors. 4300 w. Elec Engr, Lond—Oct. 27, 1905. No. 73002 A.

Polyphase Motors.

The Application of Condensers in the Operation of Polyphase Motors (Anwendung der Kondensatoren bei Dauerndem Betrieb von Drehstrommotoren). J. Dalemont. Describing a method of operating three-phase motors from a single-phase main. 3000 w. Elektrotech Zeitschr—Nov. 2, 1905. No. 73354 D.

Testing.

See Electrical Engineering, Measurement.

TRANSMISSION.

Lightning Arresters.

Note on Lightning-Arresters on Italian High-Tension Transmission Lines. Philip Torchis. A report of observations made by the writer and reporting the best practice of to-day for the protection of Italian transmission lines. 800 w. Am Inst of Elec Engrs—Oct., 1905. No. 72925 D.

Performance of Lightning-Arresters on Transmission Lines. N. J. Neall. Describes a method of obtaining, by means of test-papers, records of the operation of lightning-arresters in service; gives some results obtained by the use of this method. Ills. 3500 w. Pro Am Inst of Elec Engrs—Nov., 1905. No. 73485 D.

Shaw's Lightning Arrester. Report of the Committee on Science and the Arts, on the invention of Henry M. Shaw. Ills. 900 w. Jour Fr Inst—Nov., 1905. No. 73097 D.

Some Experiences with Lightning Protective Apparatus. Julien C. Smith. Deals with experiences with lightning protective apparatus which the operating department of the Shawinigan Water & Power Co. has had during the years 1903, 1904 and 1905. Ills. 2000 w. Am Inst of Elec Engrs—Oct., 1905. No. 72924 D.

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INDUSTRIAL ECONOMY

Coal Trade.

Problems of the Expansion of the American Coal Trade. F. E. Saward. A review of recent statistics, showing the enormous growth of the coal trade of the United States, both domestic and export. 2500 w. Engineering Magazine—Dec., 1905. No. 73376 B.

Exposition.

Mechanical and Technical Notes on the Liége Exposition (Maschen-technische Reisenotizen von der Lütticher Weltausstellung). Julius Divis. A general descriptive account of the mechanical exhibits, with professional comments. Serial. Part I. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 21, 1905. No. 73344 D.

Inspection.

The Position of the Constructing Engineer, and His Duties in Relation to Inspection and the Enforcement of Contracts. Albert J. Himes. 7000 w. Pro Am Soc of Civ Engrs—Nov., 1905. No. 73438 E.

Invention.

American Inventors in the German Patent Office. An official statement from Pres. Hauss, of the Imperial Patent Office, dealing with the treatment of American inventors as patentees in Germany. 1500 w. Elec Wld & Engr—Nov. 11, 1905. No. 73201.

Iron Industry.

The German Iron Industry in Competition for the Markets of the World (Die Deutsche Eisenindustrie und ihren Kampf um den Weltmarkt). Dr. Alexander Tille. A review of the influence of protection and free trade upon the export iron business of Germany. 5000 w. Zeitschr d Ver Deutscher Ing—Oct. 21, 1905. No. 73303 D.

The Iron and Steel Industry. A review of the production, comparing the principal iron producing countries. 3000 w. Engng—Nov. 10, 1905. No. 73290 A.

Labor.

Obstructionism, or a New Form of Strike on the Italian Railways. Explains this form of strike, relating the causes that led to it, describing how it became developed, the results, and measures taken against it. 3500 w. Bul Int Ry Cong—Oct., 1905. No. 73405 F.

The Incorporation of Labor Unions. Howard R. Bayne. Discusses the incorporation and does not consider that it should be made compulsory. 1500 w. R R Gaz—Vol. XXXIX., No. 20. No. 73228.

The Realization of Ideals in Industrial Engineering. H. F. J. Porter. A discussion of the effect of the human element upon the efficiency and working organizations in office and shop. 5500 w. Trans Am Soc of Mech Engrs (No. 082)—Dec., 1905. No. 73440.

Patents.

The Patent Law Situation. Ludwig Gutmann. A discussion on the present status of patents, with editorial comment. 3500 w. Elec Wld & Engr—Nov. 18, 1905. No. 73246.

Philippine Islands.

Labor Conditions in the Philippine Islands. J. W. Beardsley. Shows briefly some of the essential conditions surrounding the labor problem in the Philippines. 9500 w. Eng News—Nov. 23, 1905. No. 73421.

Sanitary Conditions as Affecting Contracts for Works, in the Philippine Islands. Maj. E. C. Carter. An authoritative report of present conditions. 2000 w. Eng News—Nov. 23, 1905. No. 73422.

Tabulating.

Tabulating - Machine Cost - Accounting for Factories of Diversified Product. Morrell W. Gaines. An examination of mechanical methods of analysing and tabulating records. 4000 w. Engineering Magazine—Dec., 1905. No. 73375 B.

MARINE AND NAVAL ENGINEERING

Battleships.

A Comparison of Recent Battleships. H. G. Gillmor. A comparison from the point of view of the designer and builder of the latest battleships of Gt. Britain, France, United States, Germany, Italy, and Japan. 3000 w. (No. 6.) Soc of Nav Archts & Marine Engrs—Nov. 16, 1905. No. 73188 C.

Bending Moments.

Longitudinal Bending Moments of Certain Lake Steamers. W. I. Babcock. Describes the very large ships recently put on the Lakes to meet new conditions, and

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the lengthening of the "Victory." Investigates the changes in the longitudinal bending moments in a seaway in this ship, caused by this increase in length, and compares them with the largest ships now in lake service. 13 plates. 2800 w. (No. 9.) Soc Nav Archts & Marine Engrs—Nov. 16, 1905. No. 73191 D.

Boilers.

See Mechanical Engineering, Steam Engineering.

Bulkheads.

Notes on the Strength of Water-Tight Bulkheads for Battleships and Cruisers. Harold F. Norton. Explains the tests required by the Navy Department for battleships and cruisers, and gives curves, derived from formulæ, by use of which the required results may be immediately obtained. 2 plates. 3000 w. (No. 11.) Soc of Nav Archts & Marine Engrs—Nov. 16, 1905. No. 73193 C.

Coaling Station.

The New Coaling Station at Narragansett Bay. Illustrated description of a new coaling station recently completed at Bradford, near Newport, and its operation. 3000 w. Eng Rec—Nov. 25, 1905. No. 73496.

Coast Lines.

Coastwise Steamship Lines of the United States. Illustrates and describes types of vessels belonging to the domestic marine and gives information relating to the service. Also information in regard to the domestic trade. 4000 w. Naut Gaz—Nov. 2, 1905. No. 73040.

Cruisers.

The Cruiser. Com. William Hovgaard. Gives a brief historical review with a view to studying the relation between the development and the causes which have produced and governed it, and discusses the type and design of cruisers most suitable to existing conditions. 9500 w. 4 plates. (No. 5.) Soc Nav Archts & Marine Engrs—Nov. 16, 1905. No. 73187 D.

Docks.

Floating Docks. Lyonel Edwin Clark. On types of floating docks, their advantages and capabilities, showing them to be thoroughly reliable and having in some cases distinct advantages. Discussion and correspondence. Ills. 51500 w. (No. 3500.) Inst of Civ Engrs. No. 73153 N.

The Wooden Floating Dry Dock at Mobile. Illustrations, with brief description. 700 w. Marine Engng—Nov., 1905. No. 72915 C.

Ice Yacht.

How to Build an Ice Yacht. H. Percy Ashley. Illustrates and describes how to build for the 300-sq. ft. class, which has been found most practicable. The two types of solid backbone construction most in use are shown. 2000 w. Rudder—Nov., 1905. No. 73016 C.

Lighthouse.

Beachy Head New Lighthouse. Albert Havelock Case. Illustrated detailed description of this structure and its equipment. 5300 w. Ills. (No. 3461.) Inst of Civ Engrs. No. 73176 N.

Liner.

The Twin-Screw Liner "Amerika." Illustrations, with brief description of this new Hamburg-American steamship. 1500 w. Sci Am—Nov. 4, 1905. No. 72968.

Liverpool.

Liverpool and Her Rival Ports. From the presidential address of T. Reney Smith, before the Liverpool Engng. Soc. Discusses improvements whereby the city trade and progress may be advanced, especially questions connected with the shipping facilities. 2000 w. Engr, Lond—Nov. 10, 1905. No. 73297 A.

Machinery.

Useful Data of Scotch Marine Engineering Practice. H. Wilkes. Gives tables and diagrams giving figures based upon engines, boilers, and accessories actually constructed by Scotch and English marine-engine builders. 1000 w. Marine Engng—Nov., 1905. No. 72913 C.

Mercantile Marine.

The Merchant Marine. George W. Dickie. Address, at Portland, before the Trans-Mississippi Commercial Congress. Also editorial. Discusses the difficulties with which American shipbuilders must contend, and the shipping interests of the United States. 6000 w. Marine Engng—Nov., 1905. No. 72912 C.

Motor Boats.

A Six-Cylinder 400-Horse-Power Racing Gasoline Power Boat. Illustrates and describes a racing boat built by the Brooke Motor Co. of Gt. Britain. 900 w. Sci Am—Nov. 11, 1905. No. 73092.

Internal-Combustion Motors for Marine Service (Der Gasmotor im Dienste der Schiffahrt). C. Stein. A fully illustrated account of recent liquid-fuel motors and their accompanying mechanism for boat propulsion. Two articles. 6000 w. Zeitschr d Ver Deutscher Ing—Oct. 28, Nov. 4, 1905. No. 73304 each D.

Problems in Connection with High-Speed Launches. Clinton H. Crane. Discusses points in design of boats driven by gasolene engines, especially the form of hull. 6 plates. 1500 w. (No. 15.) Soc of Nav Archts & Marine Engrs—Nov. 16, 1905. No. 73197 C.

Progressive Speed Trials of the Gasolene Launch Ludo. George Crouse Cook. Gives particulars and data of speed and

power obtained on a well designed launch. 1600 w. 4 plates. (No. 16.) Soc of Nav Archts & Marine Engrs—Nov. 16, 1905. No. 73198 C.

Recent Motor Boats with Internal-Combustion Engines (Neuere Motorboote mit Verbrennungskraftmaschinen). W. Kammerer. Describing recent motor boats in England, France, and Germany. 3500 w. Zeitschr d Ver Deutscher Ing—Nov. 11, 1905. No. 73323 D.

The Sea-Going Motor Launch "Iris." Dimensions and illustrated description of the vessel and its equipment. 1500 w. Engng—Nov. 3, 1905. No. 73133 A.

Naval Battery.

The Ultima—A Globuloid Naval Battery. Anson Phelps Stokes. Describes this proposed new naval battery, comparing with an earlier model, and giving report of experiments with a model in the Government Model Basin. 13 plates. 3000 w. (No. 7.) Soc of Nav Archts & Marine Engrs—Nov. 16, 1905. No. 73189 C.

Naval Station.

See Civil Engineering, Construction.

Ports.

Note on the Passage of Vessels in a Tidal River of Great Length. H. Crahay de Franchimont. Considers conditions needing study in planning the improvement of the depth of a navigable channel, and the preparation of route-charts. 1100 w. (No. 3579.) Inst of Civ Engrs. No. 73160 N.

The Ports of Antwerp and London. A comparison of the rival attractions of these ports, based on information from three recent reports. 1800 w. Engr, Lond—Oct. 27, 1905. No. 73010 A.

Propellers.

Experience in the Design of Screw Propellers. Horace See. Read before the Milan meeting of the International Navigation Congress. A discussion of points in propeller design, giving the more desirable formations, and information of tests and conclusions. 1200 w. Eng News Nov. 2, 1905. No. 72963.

Experimental Researches on the Performance of Screw Propellers. W. F. Durand. A report of investigations carried on in the canal of the hydraulic laboratory of Cornell University, covering in effect the performance of 49 model propellers. 36 plates. 4800 w. (No. 3.) Soc of Nav Archts & Marine Engrs—Nov. 16, 1905. No. 73185 E.

Propulsion.

Some Problems in Ferry-Boat Propulsion. Col. E. A. Stevens. A report of tests made of model wheels of the Scranton, Scandinavia and Edgewater, in the United States experimental basin. 4 plates. (No. 1.) 700 w. Soc of Nav Archts & Marine Engrs—Nov. 16, 1905. No. 73183 C.

Some Results of Tests of Model Propellers. A. V. Curtis, and L. F. Hewins. Presents results of experiments in two, four, and six-bladed propellers, at the U. S. Ex. Model Basin. 15 plates. 2000 k. (No. 4.) Soc of Nav Archts & Marine Engrs—Nov. 16, 1905. No. 73186 D.

Slipway.

Slipway at Tucacas, Venezuela. Arthur Drew Thomas. Short description, with illustration, of the construction of a slipway on the northern coast of South America. 1000 w. (No. 3511.) Inst of Civ Engrs. No. 73162 N.

Spare Fittings.

Spare Gear for Steamers. F. J. Kean. Gives lists of spare gear customary at the present time for an ocean-going steamer to carry, discussing the necessity of carrying certain fittings. 1500 w. Prac Engr—Nov. 10, 1905. Serial. 1st part. No. 73277 A.

Speed Trials.

Methods of Conducting Speed Trials. J. J. Woodward. Remarks on contract trial requirements, and a description of the methods of concluding speed trials under present conditions. Tables and plates. 20000 w. (No. 18.) Soc of Nav Archts & Marine Engrs—Nov. 16, 1905. No. 73236 G.

Submarines.

Notes on Submarine Boats (Ueber Unterseeboote). C. Stainer. A general review of the development of submarine navigation, and a discussion of the present state of the art. 5000 w. Stahl u Eisen—Nov. 1, 1905. No. 73368 D.

Turbines.

Marine Applications of the Curtis Steam Turbine. Charles G. Curtis. Information concerning vessels propelled by steam turbines of this type and the results obtained. 1500 w. (No. 12.) Soc of Nav Archts & Marine Engrs—Nov. 16, 1905. No. 73194 C.

Marine Steam Turbine Development and Design. E. M. Speakman. Reviews the rapid development that has taken place in Great Britain, compares turbines with reciprocating engines, and discusses their design. 30 plates. 8400 w. (No. 13.) Soc of Nav Archts & Marine Engrs—Nov. 16, 1905. No. 73195 D.

The Determination of the Principal Dimensions of the Steam Turbine with Special Reference to Marine Work. E. M. Speakman. Read before the Inst. of Engrs. & Shipbuilders in Scotland. Discusses the design of turbine installations, the necessary calculation for propeller di-

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mensions, &c. Ills. 3800 w. Engr, Lond —Nov. 17, 1905. Serial. 1st part. No. 73465 A.

The Turbine-Driven Steamer Viking. L. Ramakers. Illustrated detailed description. 1100 w. Marine Engng—Nov., 1903. No. 72911 C.

See also Mechanical Engineering, Steam Engineering.

Ventilation.

Experiments with Ventilating Fans and Pipes. D. W. Taylor. Describes experiments undertaken to determine the capacities and efficiencies of fans used for ventilation on U. S. naval vessels, and to obtain information for the design of systems of ventilation piping. 40 plates. (No. 2.) 11000 w. Soc of Nav Archts & Marine Engrs—Nov. 16, 1905. No. 73184 F.

Warship Design.

A Note from Japan. George W. Dickie. A note from a Japanese naval constructor is quoted, and the points named as of importance to gain a victory are discussed. 2 plates. 3000 w. (No. 8.) Soc of Nav Archts & Marine Engrs—Nov. 16, 1905. No. 73190 C.

MECHANICAL ENGINEERING

AUTOMOBILES.

Air-Cooling.

Practical Experiences with Air-Cooled Cars. Harry B. Haines. Gives some personal experiences with air-cooled machines on varying road conditions. 2800 w. Automobile—Nov. 2, 1905. Serial. 1st part. No. 73014.

Arrol-Johnston.

The Arrol-Johnston Motor Car. An illustrated detailed description of the car which won the Tourist Trophy Race in the Isle of Man. 4000 w. Engng—Nov. 10, 1905. Serial. 1st part. No. 73289 A.

Bianchi.

The Bianchi Petrol Car. Illustrates and describes these Italian cars of the chain-driven type, with four-cylinder engines and four-speed gear boxes. 700 w. Auto Jour—Nov. 18, 1905. No. 73477 A.

Braking.

Use of the Motor for Braking. Rene M. Petard. Explains the advantages to be gained by using the motor of a gasolene automobile as a brake, and the most advantageous method of obtaining a braking effect. 1800 w. Automobile—Nov. 9, 1905. No. 73100.

Brotherhood.

The "Brotherhood" Petrol Cars. Illustrated description of novel features introduced in the latest model. 700 w. Auto Jour—Nov. 18, 1905. No. 73478 A.

Economy Test.

An Automobile Economy Test. An illustrated account of the recent test carried out by the N. Y. Motor Club, to demonstrate the efficiency of the American gasoline automobile. 1000 w. Sci Am—Nov. 18, 1905. No. 73204.

Fire Appliances.

Motor Fire-Appliances for Vienna. Illustrations, with information of these self-propelled appliances. 1000 w. Engng—Nov. 10, 1905. No. 73287 A.

Garage.

Model Garage in Harlem. Illustrates and describes a new storage station in upper Manhattan Island. 1000 w. Automobile—Nov. 23, 1905. No. 73428.

Iris.

Details of the "Iris" Touring Motor-Car. Many illustrations and descriptive notes. 2700 w. Engng—Nov. 17, 1905. No. 73483 A.

The "Iris" Cars. An illustrated article describing the leading features of cars recently redesigned. 1500 w. Motor Car Jour—Nov. 11, 1905. No. 73269 A.

The 1906 Legros and Knowles "Iris" Cars. Illustrated detailed description of two touring models recently brought out. 1500 w. Auto Jour—Nov. 11, 1905. Serial. 1st part. No. 73273 A.

Kerosene.

Car Using Kerosene Oil as Fuel. Illustrates and describes a carbureter that will enable an ordinary explosion motor to run successfully on either gasoline or kerosene; and an air-cushion, which makes solid rubber tires as easy riding as pneumatic tires. 2200 w. Automobile—Nov. 9, 1905. No. 73099.

Lubricator.

The Albion Mechanical Lubricator. Calls attention to the tendency toward over-lubrication and the disagreeable results, and gives an illustrated description of a device designed to overcome these features and yet ensure efficient lubrication at all times. 1000 w. Motor-Car Jour—Nov. 11, 1905. No. 73270 A.

The Albion Mechanical Lubricator. Illustrates and describes the ingenious lubricator fitted to all Albion cars, invented

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by T. Blackwood Murray. 600 w. Autocar—Oct. 28, 1905. No. 73000 A.

Morgan.

A New All-British Car. An illustrated description of a 24 h. p. Morgan car. 1800 w. Autocar—Nov. 11, 1905. No. 73272 A.

Olympia.

Some Leading Cars at Olympia. Illustrates and describes new models of various makes exhibited. 1500 w. Auto Jour—Nov. 18, 1905. Serial. 1st part. No. 73476 A.

Peerless.

New Peerless Designs for 1906. Two new cars are to be placed on the mark t by this Cleveland, O., company, one of 30 h. p., the other 45 h. p. The 30 h. p. car is illustrated and described. 2000 w. Automobile—Nov. 23, 1905. No. 73429.

Pneumatic Hub.

The Middleton Pneumatic Hub. Illustrates and describes an invention for rendering solid-tired wheels more resilient. A pneumatic cushion surrounds the hub in much the same way that a pneumatic tire surrounds the felloe. 900 w. Auto Jour—Nov. 18, 1905. No. 73479 A.

Rolls-Royce.

Multi-Cylinder Rolls-Royce Cars—Two 8-Cylinder Models. Illustrated description of a landaulet, and a touring car having features of interest. 1500 w. Auto Jour—Nov. 11, 1905. No. 73274 A.

Serpollet.

The Serpollet Steam Vehicles. Illustrated description of recently introduced features of these vehicles. 2200 w. Engr, Lond—Oct. 27, 1905. No. 73009 A.

Shock Absorber.

Pneumatic Shock Absorber for Vehicles (Amortisseur Pneumatique pour Voitures). H. Mamy. The Bernard & Patoureau device consists of an inflated cushion interposed between the spring and the body of the vehicle. 1000 w. Génie Civil—Oct. 28, 1905. No. 73315 D.

Side-Drive.

The 25-H. P. James and Browne Side-Drive Car. Gives an illustrated description of the design of a new side-drive car. 1200 w. Autocar—Nov. 18, 1905. No. 73480 A.

Speed Gearing.

The Lloyd Change-Speed Gear. Illustrated description of this gear and its operation. 1400 w. Autocar—Oct. 28, 1905. No. 72999 A.

Steering.

Klee's Tangential Steering Gear. Illustrates and describes an invention designed to overcome a slight inaccuracy in systems having their front wheels interconnected by one tie rod of invariable length. 600 w. Auto Jour—Nov. 11, 1905. No. 73275 A.

Sunbeam.

The Sunbeam Car for 1906. Illustrated description of a new design with a 16 H.-P. engine. The chains and brakes are arranged to operate continuously in oil baths. 2800 w. Autocar—Nov. 4, 1905. No. 73122 A.

Touring Cars.

Chadwick Touring Car, 1906 Model. Illustrations and detailed description of an interesting machine built in Philadelphia. 2700 w. Automobile—Nov. 2, 1905. No. 73015.

Tractor.

The Scott Gasoline-Motor-Propelled Agricultural Tractor. Illustrates and describes an interesting tractor and its ingenious attachments, shown at the show of the British Royal Agricultural Society. 1000 w. Sci Am Sup -Nov. 4, 1905. No. 72973.

COMBUSTION MOTORS.

Balancing.

The Balancing of Multi-Cylinder Petrol Engines. An investigation made to inquire into the conditions which give rise to vibration, and the possibility of considerably reducing it by arranging the mechanism of petrol engines in such a manner as to ensure complete balancing of the inertia forces. 2000 w. Engr, Lond—Nov. 17, 1905. No. 73462 A.

Gas Engines.

The Nuremberg Gas-Engine. Illustrates and describes the principal features of this gas-engine which has recently been built in very large sizes, and extensively adopted for running with blast-furnace gas, and other cheap gases. 900 w. Engng—Nov. 3, 1905. No. 73131 A.

The Various Methods of Governing Four-Cycle Gas Engines. Rodolphe Mathot. A comparison of the hit-or-miss method with those employing regulation of the charge. 3000 w. Engineering Magazine—Dec., 1905. No. 73374 B.

Gas Producers.

Gas Producers and Producer Gas. Dr. R. S. Moss. Describes the method of producing the gas, the composition of the coal used, &c., in the present number. 1800 w. Min Wld—Nov. 11, 1905. Serial. 1st part. No. 73118.

Recent Gas Producers (Neuere Kraftgaserzeuger). R. Schöttler. Illustrating and describing improved types of suction gas-producers for direct connection to gas engines. Serial. Part I. 3500 w. Zeitschr d Ver Deutscher Ing—Nov. 11, 1905. No. 73321 D.

Results of the Preliminary Producer

We supply copies of these articles. See page 639.

Gas Tests of the United States Geological Survey Coal Testing Plant at St. Louis. R. H. Fernald. An account of the preliminary work. Ills. 2500 w. Trans Am Soc of Mech Engrs (No. 080)—Dec., 1905. No. 73442 C.

Trials of Suction Gas-Producer Plants. Report on the trials under the auspices of the Highland and Agricultural Society of Scotland. 2500 w. Mech Engr—Nov. 11, 1905. No. 73278 A.

Gas Turbines.

The Problem of the Gas-Turbine. Dugald Clerk. Inaugural address to the Jun. Inst. of Engrs. A critical review of what has been written and attempted in this field, not favorable to expectations of future success. 4500 w. Jour of Gas Lgt—Nov. 7, 1905. No. 73271 A.

Petrol Motor.

140-Horse-Power Wolseley Petrol-Motor. Illustrated description of one of the largest petrol-motors yet constructed for industrial use. Built for the General Electric Co., U. S. A., for railway traction. 2400 w. Engng—Nov. 10, 1905. No. 73288 A.

Poppet Valves.

The Pressure Drop Through Poppet Valves. Charles Edward Lucke. A report of tests made to determine the relation between pressure drop through a poppet valve and the condition of flow, form of opening, &c., that give rise to the pressure drop observed. Ills. 2800 w. Trans Am Soc of Mech Engrs, No. 084—Dec., 1905. No. 73499 D.

HEATING AND COOLING.

Heating Surface.

Determination to Heating Surface. Review of a paper by J. Nelson Russell, before the Brit. Inst. of Heat. & Ven. Engrs., explaining the writer's method of determining the amount of heating surface needed in heating and ventilating work. 2200 w. Met Work—Nov. 11, 1905. No. 73066.

Hot Air.

A Notable Departure in Furnace Heating. Illustrated description of a system introducing round risers. 2200 w. Met Work—Nov. 4, 1905. No. 72982.

Incrustation.

Hot Water Supply by Indirect Heating.—A Remedy for Incrustation Difficulties. George Chasser. Read before the Brit. Inst. of Heat. & Vent. Engrs. Discusses difficulties due to hard water, and the remedy. Diagrams. 5000 w. Plumb & Dec—Nov., 1905. No. 73121 A.

Refrigeration.

Scale. Arthur Pennell. Cause of formation of scale in ice making and refrigerating plants and method of prevention or of minimizing losses from this cause. 1500 w. Ice & Refrig—Nov., 1905. No. 73046 C.

The Relation of the Central Station to the Motor-Driven Refrigerating Machine. G. W. Goddard. Abstract of a paper read at meeting of the Edison Ill. Cos. Explains the system of the present refrigeration compression machine, and its many applications, showing the advantages of motor-driving. 1600 w. Elec Rev, N Y—Nov. 11, 1905. No. 73112.

Schools.

Heating and Ventilating a medium-Sized School Building. Gives an illustrated description of the heating and ventilating system used in Public School 132, in the Bronx, New York City. 1000 w. Heat & Vent Mag—Nov., 1905. No. 73263.

The Progress of American Schools in Regard to Health Laws. J. D. Sutcliffe. Read at meeting of the Inst. of Heat. & Vent. Engrs., London. Discusses the heating, ventilation, sanitation and fire appliances from an English engineer's point of view. 3000 w. Heat & Vent Mag—Nov., 1905. No. 73265.

Steam Heating.

Sketch Details of Heating Installations. Frank G. McCann. Gives special sketch details prepared for use of New York City Board of Education. 1200 w. Heat & Vent Mag—Nov., 1905. No. 73262.

Steam Heating of Classrooms on a Recreation Pier in New York City. Illustrated description of an unusual installation made necessary by the need of temporary school accommodations. 2500 w. Met Work—Nov. 4, 1905. No. 72984.

Ventilation.

The Ventilation System in the Royal Uranium Color Works at St. Joachimsthal (Die Ventilationsanlage in der K. K. Uranfarbenfabrik zu St. Joachimsthal). F. Janda. Describing an arrangement of exhaust pipes and hoods over the tanks containing the alkaline solutions. 1800 w. Oesterr Zeitschr f Berg u Hüttenwesen—Nov. 4, 1905. No. 73345 D.

HYDRAULICS.

Centrifugal.

The Efficiency of Centrifugal Pumps (Die Kreisel und ihre Leistungen). H. Hagens. An appendix to a previous paper giving a mathematical examination of the tests previously recorded. 2000 w. Zeitschr d Ver Deutscher Ing—Oct. 28, 1905. No. 73305 D.

Flow.

The Discharge of Water Through Street Taps and House Service Pipes.

We supply copies of these articles. See page 639.

William Paul Gerhard. Gives double-page diagram with curves plotted by formulæ, and explanation of its use. 2500 w. Cassier's Mag—Nov., 1905. No. 72986 B.

The Gauging of Streams by Chemical Means. Charles Edmond Stromeyer. Describes the means by which the chemical method can be most successfully applied in practice. 3500 w. Ills. (No. 3514.) Inst of Civ Engrs. No. 73181 N.

The Resistance Offered to the Flow of Water in Pipes by Bends and Elbows. Connell William Long Alexander. Describes an experimental investigation of the nature and magnitude of the resistance offered by bends, knees, and elbows, to the flow of water through closed pipes. 5300 w. Ills. (Students' Paper No. 526.) Inst of Civ Engrs. No. 73178 N.

The Velocity of Water Flowing Down a Steep Slope. Ernest Prescot Hill. Gives investigations and the assumptions involved. 800 w. (No. 3520.) Inst of Civ Engrs. No. 73161 N.

Plumbing.

The Durham System of Plumbing. A serial, in three parts, illustrating and describing this system. 1300 w. Met Work—Nov. 4, 1905. Serial. 1st part. No. 72983.

Pumping Plant.

See Civil Engineering, Water Supply.

Pumps.

An Unusual Pump. Illustrated description of an installation for the water supply of Catlettsburg and Ashland, Ky., explaining the conditions it is adapted to meet. 1800 w. Eng Rec—Nov. 25, 1905. No. 73498.

Turbine Plants.

Preliminary Plans for Turbine Plants (Erster Entwurf von Turbinenanlagen). N. Baashuus. Discussing the simple calculations required to determine the general questions involved in the planning of a hydraulic turbine installation. 4000 w. Elektrotech Zeitschr—Oct. 18, 1905. No. 73347 B.

Valves.

The Slip of Discharge Valves. C. H. Benjamin. A report of experiments made to determine the effect of variations in the lift and stiffness of the spring on the discharge through the valves of a feed pump. 700 w. Engr, U S A—Nov. 15, 1905. No. 73259 C.

MACHINE WORKS AND FOUNDRIES.

Air Furnaces.

Operation of Air Furnaces. L. G. Blunt. Discusses the method of making up the bottom, of calculating the charge, of placing metal in furnace, flame regulation, and taking of the fracture tests. Ills. 1200 w. Foundry—Nov., 1905. No. 72917.

Boring Mill.

A Floor Plate Boring Mill at the Crocker-Wheeler Works. Illustrated detailed description of machinery used in the construction of heavy electrical apparatus. 2000 w. Mach, N Y—Nov., 1905. No. 72938 C.

Cartridge Cases.

The Manufacture of Cartridge-Cases for Quick-Firing Guns. Col. Leandro Cubillo, and Archibald P. Head. Illustrates and describes the new plant at the Royal Spanish Arsenal at Trubia, Spain, for the manufacture of brass cartridge-cases, stating the advantages of metal cases, and giving some of the mechanical properties which show brass to be best suited for this service. 9000 w. Inst of Mech Engrs—Oct. 20, 1905. No. 73006 D.

Castings.

Making a Clutch Coupling on the Molding Machine. George Buchanan. An illustrated description of the method employed. 700 w. Am Mach—Vol. 28. No. 45. No. 73078.

Making a Pattern and Mold for a Power Press. R. H. Palmer. Illustrates and describes inexpensive method of making a pattern when only one casting is required. 1800 w. Am Mach—Vol. 28. No. 46. No. 73213.

Standard Specifications for Gray Iron Castings. Gives the specifications adopted by the American Society for Testing Materials. Ills. 600 w. Ir Trds Rev—Nov. 2, 1905. No. 72976.

Chemistry.

Chemistry in Foundry Operation (Die Chemie im Giessereibetriebe). C. Henning. An address showing the value of applied chemistry in connection with daily foundry work. Serial. Part I. Stahl u Eisen—Nov. 1, 1905. No. 73371 D.

Cores.

Venting Difficult Cores. Walter J. May. Suggestions for making vents or gas passages in unusual shapes. Ills. 600 w. Prac Engr—Nov. 3, 1905. No. 73125 A.

Cranes.

See Mechanical Engineering, Power and Transmission.

Drills.

Six-Spindle Special Driller. Illustrated description of a machine built for drilling the spanner holes in small hardware and machine parts all at one operation. 600 w Am Mach—Vol. 28. No. 46. No. 73215.

Electrical Works.

The East Pilton Works of Messrs. Bruce Peebles & Co., Ltd. Illustrated de-

scription of the largest works for making electrical machinery in Scotland, at Edinburgh. 1800 w. Elec Rev, Lond—Nov. 17, 1905. Serial. 1st part. No. 73458 A.

Exposition.

See Industrial Economy.

Galvanizing.

The Galvanizing of Iron and Steel Surfaces. Sherard Cowper-Coles. Illustrates and describes the hot galvanizing process, and the electro or cold galvanizing process, giving related information. 4800 w. Ir & Coal Trds Rev—Nov. 10, 1905. No. 73427 A.

Grinder.

Mayer's Twist Drill Grinder. Illustrated description of a machine for automatically grinding twist drills recently devised by G. M. Meyer, of Germany. 1100 w. Mech Eng—Oct. 28, 1905. No. 72996 A.

Hooks.

The Theory of Hooks. Walter Rautenstrauch. Gives the theory recently developed by Mr. E. S. Andrews and Prof. Karl Pearson, and extracts from experiments conducted to prove it. Ills. 1500 w. Sib Jour of Engng—Oct., 1905. No. 73486 C.

Lathe.

The Lo-Swing Lathe. Illustrations, with description, of a novel lathe design, explaining its object. 1700 w. Am Mach —Vol. 28. No. 44. No. 72949.

Lathe Works.

Lang's Lathe Works at Johnstone, Scotland. J. William Chubb. Illustrated detailed description. 3200 w. Am Mach—Vol. 28. No. 44. No. 72948.

Machinery Foundations.

The Anthoni-Prache Foundation System for the Prevention of Noise and Vibrations (Fondations Isolantes Anthoni-Prache). Describing a system for absorbing vibrations by the interposition of sheets of rubber between machines and foundations. 4000 w. Mem Soc Ing Civ de France—Sept., 1905. No. 73335 G.

Machine Tools.

Machine Tools at the Liége Exposition (Die Weltausstellung in Lüttich, 1905. Die Werkzenmaschinen). G. Schlesinger. The first of a series of fully illustrated articles showing the machine tools from various countries exhibited at Liége. Part I. 2500 w. Zeitschr d Ver Deutscher Ing —Nov. 4, 1905. No. 73306 D.

Milling.

Milling Machine Fixtures. The present article considers the milling machine vise, which has a stationary and a movable jaw, against which are placed removable jaws, held in place by means of screws. Ills. 2000 w. Mach, N Y—Nov., 1905. Serial. 1st part. No. 72940 C.

Molding.

Molding a Large Gear Wheel. Samuel Groves. An illustrated detailed description of the Groves' Portable Gear Molding Machine and its operation. 3000 w. Can Engr—Nov., 1905. No. 73051.

Molding a Three Way Cock. H. J. McCaslin. Gives method used in molding a rather difficult casting. Ills. 500 w. Foundry—Nov., 1905. No. 72919.

Molding Machine Equipment. T. E. Vanderslice. Illustrates and describes special devices for use on molding machines, their use, etc. 3800 w. Am Mach—Vol. 28. No. 45. No. 73076.

Molding Machine Practice. F. W. Hall, in *The Patternmaker.* Shows a special casting mounted on different types of machines, and discusses the advantages and disadvantages of one type compared with the other. 2500 w. Foundry—Nov., 1905. No. 72920.

Object Lessons.

Fads and Fancies. W. E. Symons. A discussion of some object lessons in the mechanical department. General discussion. 10800 w. Pro W Ry Club—Oct. 17, 1905. No. 73410 C.

Patterns.

Metal Foundry Patterns. Walter J. May. Considers when it is worth while to make metal patterns, points of importance in making them, their advantages, cost, and related matters of interest. 3000 w. Sci Am Sup—Nov. 25, 1905. No. 73418.

Repairs.

Designing Machinery to Facilitate Repairs. Joseph Horner. An illustrated article offering suggestions in design that will facilitate the quick removal of the parts of a machine most subject to wear, and the substitution of new parts. 3500 w. Cassier's Mag—Nov., 1905. No. 72988 B.

Saw.

The Taylor-Newbold Saw. S. Newbold. Read before the Phila. Found. Assn. Illustrates and describes this tool and its operation. 2000 w. Foundry—Nov., 1905. No. 72918.

Shop Practice.

Machine Shop Practice. G. M. Campbell. Discusses chiefly the equipment of the shops, indicating how much can be done in the way of cheapening the output. Also discussion. 9000 w. Pro Engrs' Soc of W Penn—Nov., 1905. No. 73412 D.

Steel Tubes.

The Manufacture of Weldless Steel Tubes. John David Morgan. Describes the methods of manufacture as conducted

at the present time. 5500 w. (Students' Paper No. 515.) Ills. Inst of Civ Engrs. No. 73175 N.

Upsetting.

Tube-Upsetting Machine (Röhrenstauchmaschine). Carl Wadas. Describing a hydraulic press for upsetting or thickening the walls of wrought tubing by longitudinal pressure. 1200 w. Stahl u Eisen—Nov. 1, 1905. No. 73370 D.

MATERIALS OF CONSTRUCTION.

Alloys.

Ferrovanadium. Dr. Ohly. Discusses properties of some alloys in iron and steel, especially the remarkable qualities of chrome-vanadium steel in regard to strength and ductility. 2500 w. Mines & Min—Nov., 1905. No. 73038 C.

Magnetic Alloys. V. Quittner. Translated from *Prometheus*. Information concerning recent studies of magnetic alloys and the results. 2000 w. Sci Am Sup—Nov. 4, 1905. No. 72971.

Heat Treatment.

The Heat Treatment of Steel in Large Masses (Wärmebehandlung von Stahl in Grossen Massen). O. Bauer. A comparison of the conditions existing in laboratory tests with those obtaining in actual practice, especially as regards mass and time. 2500 w. Stahl u Eisen—Nov. 1, 1905. No. 73369 D.

Stresses.

Simplified Methods for Rendering Neutral Layers Visible (Vereinfachtes Verfahren zur Sichtbarmachung der Neutralen Schichte). Otto Hönigsberg. An account of experiments upon glass beams with polarized light, supplementing those of the author published in March, 1904. 1200 w. Zeitschr d Oesterr Ing u Arch Verein—Oct. 20, 1905. No. 73327 D.

Testing.

The American Society for Testing Materials. Paul Kreutzpointner. An address on the work, value, and national economic aims and importance of this society. 4500 w. Pro Engrs' Soc of W Penn—Oct., 1905. No. 72981 D.

Tool Steels.

High-Speed Steel in the Factory. O. M. Becker. The fourth article deals with the design and operation of tools and machines for use with high-speed steel. 6000 w. Engineering Magazine—Dec., 1905. No. 73378 B.

The Practical Use and Economy of High-Speed Steel. J. M. Gledhill. Abstract of a paper read before the Glasgow & W. of Scotland Foremen Engrs. & Ironworkers Assn. Gives some comparative experiments with a view to ascertaining the saving in power absorbed with high-speed cutting. Illustrates some machines, and work accomplished. 2700 w. Ir & Coal Trds Rev—Nov. 17, 1905. No. 73461 A.

MEASUREMENT.

Air Flow.

On the Measurement of Air Flowing Into the Atmosphere Through Circular Orifices in Thin Plates and Under Small Differences of Pressure. R. J. Durley. Describes experiments made at McGill University. Ills. 5000 w. Trans Am Soc of Mech Engrs (No. 081)—Dec., 1905. No. 73441 D.

Dynamometer.

A New Swiss Dynamometer. Emile Guarini. Illustration, with description of a new type of geared dynamometer, having a capacity of 12 horse-power. 800 w. Am Mach—Vol. 28, No. 46. No. 73214.

Nozzles.

Experiments Upon the Flow of Gases in the Laval Type of Nozzle (Untersuchung der Gasströmung in der Laval Düse). Adolf Langrod. A study of experiments in cases in which the pressure in the most contracted portion is higher than the critical value. Two articles. 4000 w. Zeitschr d Oesterr Ing u Arch—Oct. 20, 27, 1905. No. 73328 each D.

Pyrometer.

The Fery Radiation Pyrometer. Illustrates and describes an instrument intended for the measurement of the temperature of furnaces of all kinds. 1500 w. Am Mach—Vol. 28. No. 46. No. 73217.

Slide Rule.

Short Cuts on the Slide Rule. Carl P. Nachod. Explains the use of the slide rule for calculations, showing its value. 900 w. Am Mach—Vol. 28. No. 46. No. 73216.

Spring-Balance.

The Corrections to be Applied to the Readings of a Spring-Balance When Used Horizontally or on a Slope. Alfred Ernest Young. Discusses the corrections needed. 800 w. (No. 3532.) Inst of Civ Engrs. No. 73159 N.

Straightedges.

How a Knife-edge Straightedge Was Made. F. N. Gardner. Describes some of the methods that led to success, and indicates "how not to do it." Ills. 2000 w. Mach, N Y—Nov., 1905. No. 72942 C.

Temperature.

Calculating Temperature Rises With a Slide Rule. Miles Walker. Describes a method which takes into account the changes of temperature coëfficient with temperature. 600 w. Elec Jour—Nov., 1905. No. 73408.

We supply copies of these articles. See page 639.

Torsion Meter.

An English Torsion Meter. C. Smith. Illustrates and describes an instrument for finding the torsion of revolving shafts, and thus ascertaining the horsepower developed. 1400 w. Engr, U S A—Nov. 1, 1905. No. 73953 C.

POWER AND TRANSMISSION.

Belts.

A Contact Roller for Belts (L'Enrouleur de Courroies). J. Teisset. A discussion of the advantages of auxiliary pulleys for increasing the arc of contact of belts with pulleys. 7000 w. Mem Soc Ing Civ de France—Sept., 1905. No. 73336 G.

Belts and Belt Driving (Ueber Riemen und Riementriebe). Fritz Krull. With tables of power transmitted, and illustrations of methods of driving. The construction and care of belts are discussed. Two articles. 7500 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 3, 10, 1905. No. 73331 each D.

Cableways.

Kotagudi Aerial Ropeway and Connecting Roads in North Travancore. Richard Fenwick Thorp. Describes the Construction of a ropeway, a tramway, and a cart road to improve transportation in a mountainous portion of India. Ills. 4200 w. (No. 3524.) Inst of Civ Engrs. No. 73170 N.

The Aerial Ropeway at the Rother Vale Collieries. Illustrated description of a ropeway to carry 2-ton loads, recently put in operation. 1500 w. Ir & Coal Trds Rev—Oct. 27, 1905. No. 73013 A.

Coal Handling.

Coal Handling and Storage. Charles H. Parker. Read before the Assn. of Edison Ill. Cos. An illustrated description of the apparatus installed at the South Boston Plant of the Edison Illuminating Company. 4500 w. Cent Sta—Nov., 1905. No. 73111.

Compressed Air.

A Central Compressed Air Power Plant for Heavy Railroad Construction. Lucius I. Wightman. Description, with illustrations, of the central station located near Safe Harbor, for carrying on extensive railway work on the low grade freight line of the Pennsylvania R. R. 3000 w. Eng Rec—Oct. 28, 1905. No. 72904.

Cranes.

A Fifty-Ton Electric Crane. Illustrated description of the mammoth electric crane for the new graving dock at Southampton. 900 w. Sci Am Sup—Nov. 25, 1905. No. 73416.

An Interesting 40-Ton Block-Setting Crane for Harbor Construction. Illustrated description of a crane with a radius of 115 feet, recently built in Great Britain for the construction of the harbor at Table Bay in South Africa. 900 w. Sci Am Sup—Nov. 4, 1905. No. 72972.

Electric Cranes. Claude William Hill. States the requirements where large quantities of material must be handled, and the advantages of electrical driving, discussing the worm-gear, bearings, motors and controllers, etc. Diagrams. 4800 w. (No. 3515.) Inst of Civ Engrs. No. 73179 N.

Electric Traveling Crane at the Liége Exposition (Elektrisch Betriebener Laufkran auf der Weltausstellung in Lüttich, 1905). Andreas Stamm. Illustrated description of 30-ton traveling crane of 79 feet span. 1200 w. Zeitschr d Ver Deutscher Ing—Nov. 11, 1905. No. 73324 D.

Locomotive Cranes as Labor Savers. Lewis Glasgow Howlett. Illustrates and describes some of these cranes and their operation, and the uses to which they have been applied. 2500 w. Cassier's Mag—Nov., 1905. No. 72987 B.

Elevator.

The Electric Elevator on the Burgenstock (L'Ascenseur Electrique du Burgenstock). P. Chignaterie. An illustrated description of the tower and lift giving access to the high cliffs on the banks of the lake of Lucerne, Switzerland. 1000 w. Génie Civil—Oct. 21, 1905. No. 73309 D.

Tests of Elevator Plant in the Trinity Building, New York City. Arthur J. Herschmann. A report of commercial tests made while the plant was in regular operation. Tables. Ills. 1500 w. Trans Am Soc of Mech Engrs (No. 079)—Dec., 1905. No. 73443 C.

Fans.

Centrifugal Fans. Thomas H. Johnson. Data on the performance of fans and a discussion of the influence of the structure or design, reporting tests. General discussion. Ills. 9500 w. Pro Engrs' Soc of W Penn—Nov., 1905. No. 73411 D.

Fly Wheels.

Exact and Approximate Methods of Fly-Wheel Computation (Die Genaue und die Angenäherte Schwungradermittlung). Dr. R. Proell. An examination of the graphical and analytical methods of computing fly-wheel weights for given cylinder conditions. 2000 w. Zeitschr d Ver Deutscher Ing—Oct. 21, 1905. No. 73301 D.

Gearing.

On the Location of the Pitch Circle in Worm Gearing. Ralph E. Flanders. Points out the limitations to the recommendations made by Mr. Perrigo and Mr. Edgar. Ills. 2700 w. Mach, N Y—Nov., 1905. No. 72941 C.

We supply copies of these articles. See page 639.

Governors.

Centrifugal Governors (Les Régulateurs à Force Centrifuge). L. Rith. A general study of the principles involved in the design of centrifugal governors for the speed regulation of prime movers. 10000 w. Mem Soc Ing Civ de France—Sept., 1905. No. 73334 G.

Power Distribution.

See Electrical Engineering, Distribution.

Wind Power.

The Electrical Value of Wind Power. Editorial Review of what has been accomplished in the electrical utilization of wind power. 1500 w. Sci Am—Nov. 18, 1905. No. 73203.

The Mechanical Effect Produced by Windmills (Sur le Travail Mécanique Fourni par les Moulins à Vent). M. Ringelmann. Data and results of tests upon a windmill used for pumping water. The velocity of the wind and the rotative speed of the wheel were recorded automatically. 1200 w. Comptes Rendus—Oct. 30, 1905. No. 73326 D.

STEAM ENGINEERING.

Boiler Appliances.

Improvements in Steam-Boiler Operation (Neuerungen im Dampfkesselbetriebe). Describing especially a filter for removing oil from feed water; also boiler cleaning appliances. 1200 w. Glückauf—Oct. 21, 1905. No. 73339 D.

Boiler Explosion.

Explosion of a Locomotive at the St. Lazare Station, Paris (Explosion d'une Locomotive aux Abords de la Gare Saint-Lazare, Paris). Ch. Frémont. With photographs of the fragments and a discussion of the probable manner and cause of an explosion which occurred July 4, 1904. 2500 w. Génie Civil—Oct. 21, 1905. No. 73310 D.

Boilers.

Some Notes on Steam Boiler Troubles. Horace See. Shows how some of the troubles can be directly traced to bad design and points out the characteristics found responsible for their occurrence. 2 plates. 2000 w. (No. 10). Soc Nav Archts & Marine Engrs—Nov. 16, 1905. No. 73192 C.

The Dürr Water-Tube Boiler in H. M. S. "Roxburgh." Illustrations with description and report of trials. 1600 w. Engng—Nov. 3, 1905. No. 73132 A.

Coal Handling.

See Mechanical Engineering, Power and Transmission.

Compression.

Efficiency in Compression in Steam Engines. Prof. Robert H. Smith. Discusses the most efficient limit of compression, the efficiency being measured by horse-power per unit quantity of steam used per hour. 2500 w. Engr, Lond—Nov. 3, 1905. No. 73135 A.

Condensers.

Condensers for Steam Engines and Turbines. Frank Foster. Points out the general principles underlying condenser design, showing how the working conditions affect the design; especially considering the most economical vacuum. Ills. 3500 w. Mech Engr—Oct. 28, 1905. Serial. 1st part. No. 72997 A.

Draft.

Natural and Induced Draft. John W. Cobb. Read before the Yorkshire Sec. of the Soc. of Chem. Ind. An explanation of how a chimney does its work, and also a discussion of induced draft and its advantages. 2500 w. Prac Engr—Oct. 27, 1905. Serial. 1st part. No. 72993 A.

Engines.

German Rolling Mill Engines and Their Design. An illustrated article discussing single cylinder engines, compound engines, and triple expansion engines. 1800 w. Ir & Coal Trds Rev—Nov. 3, 1905. Serial. 1st part. No. 73138 A.

600 Horse-Power Horizontal Tandem Compound Condensing Engine. Illustrated description of an engine for driving directly a Jaspar dynamo. The combined plant is ordered for the Mechlin Locomotive Works. 1500 w. Engr, Lond—Nov. 10, 1905. No. 73295 A.

Exhaust Steam.

Increasing Profits of a Central Station. George E. Walsh. Calls attention to methods of economizing by utilizing exhaust steam, hot water circulating systems, etc. 2500 w. Am Elect'n—Nov., 1905. No. 73055.

Firing.

Is Machine Stoking Economical? Alfred W. Bennis. Abstract of a paper read before the Keighley Assn. of Engrs. Gives facts tending to prove the economy. 1700 w. Elect'n, Lond—Oct. 27, 1905. No. 73004 A.

The Burning of Fuel. Editorial on the burning of coal, especially in locomotives, and the effect of large grate area. 1000 w. Ry & Loc Engng—Nov., 1905. No. 72933 C.

Fuel.

The Utilization of Low Grade Fuels for Steam Generation. W. Francis Goodrich. A comparison of the theoretical value of high grade and low grade fuels on the basis of economy in money. 3500 w. Engineering Magazine—Dec., 1905. No. 73373 B.

We supply copies of these articles. See page 639.

Gas Firing.

Natural Gas Under Steam Boilers. Jay M. Whitham. Gives the results of the author's investigations. The tests show that the best coal efficiency cannot be obtained with gas. 2500 w. Trans Am Soc of Mech Engrs (No. 078)—Dec., 1905. No. 73444.

Lubrication.

Engine Friction and Lubricants. R. T. Strohm. Discusses the effect of friction, the theory and the action of a lubricant, the selection of lubricants, and their use. 2000 w. Am Elect'n—Nov., 1905. No. 73056.

Oil Fuel.

A Good Way to Burn Oil. E. H. Notthoff. Describes the method used with success by the writer. Ills. 1200 w. Engr, U S A—Nov. 15, 1905. No. 73260.

Some Observations on Oil Burners. John J. Smith. An account of experiments with these burners. Ills. 1800 w. Am Mach—Vol. 28. No. 45. No. 73075.

Steam.

The Thermal Properties of Saturated and Superheated Steam Between 100 and 180 Degrees (Die Thermischen Eigenschaften des Gesättigten und des Ueberhitzten Wasserdampfes zwischen 100 und 180 C.). O. Knoblauch, R. Linde and H. Klebe. An account of researches repeating the work of Regnault, at the Technical High School at Munich. Two articles. 10000 w. Zeitschr d Ver Deutscher Ing—Oct. 21, 28, 1905. No. 73300 each D.

Steam Pipes.

Steam-Pipe Arrangements. William H. Fowler. A discussion of the leading principles that should govern the design and arrangement of steam-pipe installations. 2000 w. Mech Engr—Nov. 4, 1905. Serial. 1st part. No. 73126 A.

Superheating.

A Study of a Semi-Portable Compound Engine with Double Superheating (Étude sur un Type de Locomobile Demi-Fixe Compound avec Double Surchauffe). Ch. Dantin. A report of tests on the Wolf compound engine with intermediate superheater. The thermal efficiency was 19.5 per cent. 2000 w. Génie Civil—Oct. 28, 1905. No. 73314 D.

Turbines.

Design and Construction of Steam Turbines. Frank Foster. The articles are intended to go beyond the popular description of turbines, but not to be so deeply involved in mathematics as to be above the intelligence of the practical engineer. 1800 w. Mech Engr—Oct. 28, 1905. Serial. 1st part. No. 72994 A.

Simple Steam Turbine Engines. John Richards. Read before the Tech. Soc. of the Pacific Coast. Explains types now in use, the main distinction between steam and water turbines, the action, and briefly reviews various engines showing the development. Ills. 4000 w. Am Mach—Vol. 28, No. 45. Serial. 1st part. No. 73077.

The New 1,000 K.W. Turbodynamo at the Courl Mine (Die Neue 1,000 K.W. Turbodynamo der Zeche Courl). F. Schulte. Describing a 1,500 h. p. Zoelly steam turbine, coupled to a Siemens-Schuckert alternator, the current being used in the Courl mine, in the Dortmund district. 2000 w. Glückauf—Nov. 11, 1905. No. 73342 D.

The Regenerator and Interheater System Applied to the Steam Turbine (Wärmerückführung und Zwischenheizung im Dampfturbinenbetriebe). J. Nadrowski and H. Dahlke. Describing the results obtained by the use of the regenerative principle in steam-turbine operation. Serial. Part I. 3500 w. Zeitschr d Ver Deutscher Ing—Nov. 11, 1905. No. 73322 D.

See also Marine and Naval Engineering.

Valve Gears.

A New Valve Gear Embodying a Novel Mechanical Movement. Illustrates and describes an interesting valve gear recently designed by E. J. Armstrong, of the Ball Engine Co., Erie, Pa. 1400 w. Mach, N Y—Nov., 1905. No. 72939 C.

Correcting a Faulty Valve Gear. H. A. Davis. Describes method and shows results. 800 w. Engr, U S A—Nov. 1, 1905. No. 72952 C.

Marshall's Valve Gear. Illustrated detailed description of a successful valve gear, the invention of James T. Marshall. 2000 w. Engr, Lond—Nov. 3, 1905. No. 73137 A.

Valves.

The Globe Valve—Its Origin and Development. J. O'Meara. An illustrated account of the origin and development of this steam valve. 1000 w. Heat & Vent Mag—Nov., 1905. No. 73264.

Various Applications of Balanced Cylindrical Slide Valves (Verschiedene Verwendungen des Entlasteten Rohrschieberventiles). F. Strnad. With illustrations of a variety of steam valves using tubular piston devices to relieve the steam pressure. 3000 w. Zeitschr de Ver Deutscher Ing—Nov. 4, 1905. No. 73308 D.

We supply copies of these articles. See page 639.

MINING AND METALLURGY

COAL AND COKE.

Coal.

Coal; Its Uneconomic Use and Abuse. John Livingstone. Discusses its uneconomic use and abuse generally, by steam makers, but especially by the railways, and how to save 50 per cent. Also general discussion. 17000 w. Pro St. Louis Ry Club—Oct. 13, 1905. No. 72979.

Coalfeld.

The West Moreton (Ipswich) Coalfield. Walter E. Cameron. A report of the chief producing coalfield of Queensland, with special reference to the Bundamba district. 4500 w. Queens Gov Min Jour—Sept. 15, 1905. Serial. 1st part. No. 72975 B.

Coal Handling.

See Mechanical Engineering, Power and Transmission.

Coal Resources.

Coal Resources Along the Line of the Moffat Road. Arthur Lakes. Describes the two principal sources of coal along the route of this railway, the character and quality of the coal, and the general geology of the region. 1600 w. Min Wld —Nov. 11, 1905. Serial. 1st part. No. 73116.

Coal Trade.

See Industrial Economy.

Explosion.

The Clydach Vale Explosion, South Wales. James Ashworth. An account of this explosion, showing weak points of watering, and of construction in safety lamps. Ills. 3700 w. Mines & Min—Nov., 1905. No. 73032 C.

Peat.

The Application of Peat-Fuel. L. A. Stillings. Gives information concerning peat and its use, the large deposits in the United States, and the methods of preparing it for fuel, describing some processes. 2500 w. Elec-Chem & Met Ind—Nov., 1905. No. 73071 C.

The Present Status of the Peat-Fuel Industry in the United States. A. Frederick Collins. An illustrated description of the new fuel plant at New Rochelle, N. Y., and general information concerning peat-fuel. 2500 w. Sci Am Sup—Nov. 18, 1905. No. 73205.

Submarine Mining.

Submarine Coal Mining. A. Selwyn-Brown. Information concerning the dangerous risks in the submarine mines of New South Wales, due to the thinness and insecurity of the cover. 500 w. Eng & Min Jour—Nov. 18, 1905. No. 73237.

Testing.

Coal Testing. Myles Brown. On the value of true sampling, the methods and articles required; the apparatus for the analysis of coal, estimation of moisture, &c. 3000 w. Mines & Min—Nov., 1905. Serial. 1st part. No. 73034 C.

Thin Veins.

Mines Nos. 1 and 2 of the National Mining Co. James Collins. Illustrated description of the two best equipped mines in the Pittsburg thin-vein district. 2500 w. Mines & Min—Nov., 1905. No. 73030 C.

COPPER.

Copper Slag.

A Co-operative Analysis of a Copper Slag. Thorn Smith. A report showing the need of better chemical work by practical demonstration. 4000 w. Elec-Chem & Met Ind—Nov., 1905. Serial. 1st part. No. 73069 C.

Cyanides.

The Double Cyanides of Copper. Leonard M. Green. Explains tests for determining the cupric- and cuprous-potassium cyanides. 900 w. Eng & Min Jour—Nov. 18, 1905. No. 73243.

Mexico.

Plant of the Cananea Con. Copper Co., Cananea, Sonora, Mexico. O. P. Findley. Illustrated description of an efficient plant averaging about 6,000,000 lbs. per month. 1800 w. Min & Sci Pr—Nov. 18, 1905. Serial. 1st part. No. 73473.

GOLD AND SILVER.

Amalgamation.

The Separation of Silver from Sulphide in Amalgamation Processes (Ueber die Absscheidung des Silbers aus Schwefelsilber in Amalgamationsverfahren). Tosio Watanabe. A review of practice in Europe and America in comparison with results at Sado, in Japan. 2000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Nov. 11, 1905. No. 73346 D.

Borneo.

The Occurrence of Gold in Upper Sarawak. J. S. Geikie. Read before the Inst. of Min. & Met. An illustrated description of the auriferous deposits occurring in the neighborhood of Bau and Bidi, in upper Sarawak. 3500 w. Min Jour—Nov. 18, 1905. Serial. 1st part. No. 73460 A.

We supply copies of these articles. See page 639.

Cyanide.

Notes on Improvements in the Cyanide Treatment of Sands and Slimes. C. H. Pead. Gives suggestions from the writer's experience. 1400 w. Jour Chem, Met, & Min Soc of S Africa—Sept., 1905. No. 73123 E.

Dredging.

Dredging for Gold in the Nome Goldfields. Otto Halla. A brief account of the successful working of this field. 700 w. Min & Sci Pr—Nov. 18, 1905. No. 73474.

Egypt.

Gold Mining in Egypt. An illustrated article describing the ancient methods of mining, and reviewing the history of these mines. 2200 w. Min & Sci Pr—Nov. 11, 1905. No. 73233.

Feeders.

An Improvement on Swinging Feeders in Stamp Mills. Paul J. Johnson. Gives a sketch and explanatory notes of a scheme for improving the action of such feeders. 500 w. Min Rept—Nov. 23, 1905. No. 73475.

Goldfields.

Talgai and Thane's Creek Goldfields. Lionel C. Ball. Notes on the mines of these fields. 5000 w. Queens Gov Min Jour—Oct. 14, 1905. No. 73453 B.

Ore Reduction.

Description of the Ore Reduction Plant and Process of Reduction on the Oroya-Brownhill Gold Mines. Robert Allen. Describes the character of the ores and gives a sketch plan of the plant. The Diehl process is used. 4000 w. Min Jour—Oct. 28, 1905. No. 73005 A.

Ore Treatment.

Plant for the Handling and Treatment of Ores, at the Silver Cup and Nettie L. Mines, British Columbia. George Attwood. Describes the scheme for the transportation of the ore and extraction of the metals on the spot in a mountainous district where the climate is severe. 5000 w. Ills. (No. 3486.) Inst of Civ Engrs. No. 73177 N.

Rhodesia.

Four Typical Rhodesian Gold Mines. Theo. F. Van Wagenen. Illustrations, with brief descriptions of the Tebekwe, the Wanderer, the Bonsor, and the Veracity mines. 1000 w. Min & Sci Pr—Nov. 4, 1905. No. 73107.

The Mines of Rhodesia. J. H. Curle, in *The Economist*. An explanation of the condition of the gold mines, leaving the conclusions to the reader. 1200 w. Eng & Min Jour—Nov. 4, 1905. No. 73017.

Silver-Cobalt.

The New Silver-Cobalt District of Ontario, Canada. Chauncey E. Butler. An account of the recent remarkable discoveries of cobalt, nickel, and silver ore. 800 w. Min Rept—Nov. 2, 1905. No. 73042.

Sluice.

Sluice Building on Placer. Dennis H. Stovall. Calls attention to important features in the construction of a sluice. Ills. 900 w. Min Wld—Nov. 4, 1905. No. 73045.

Smelting Works.

Britannia Smelting Co.'s Smelting Works at Crofton, Vancouver Island, B. C. Illustrated description of the works and their equipment. 2500 w. B C Min Rec—Oct., 1905. No. 73255 B.

Tonopah.

The Geology of Tonopah. J. E. Spurr. Outline of Professional Paper No. 42, U. S. Geol. Surv. A report of the geology of this region. 1800 w. Eng & Min Jour—Nov. 18, 1905. No. 73240.

IRON AND STEEL.

Australia.

Australian Iron and Iron Ore. John Plummer. Reviews the industry, its development and future outlook. 1500 w. Min Wld—Nov. 4, 1905. No. 73044.

Blast Furnaces.

Some Mexican Charcoal Blast-Furnaces. John Birkinbine. An illustrated article giving information of some of the older plants which depend upon charcoal as fuel. 1400 w. Cassier's Mag—Nov., 1905. No. 72985 B.

Desulphurization.

Experimental Desulphurization. Reginald Meeks. Describes experiments made with manganese ore, and considers the use of low sulphur materials, and the use of ferro-manganese in the ladles or in the cupola to be the only positive methods of obtaining low sulphur in castings. 2000 w. Ir Age—Nov. 9, 1905. No. 73053.

Dry Air Blast.

Dry Air for Blast Furnaces. Abstracts of unpublished papers presented at the Liége Mining and Metallurgical Congress. 3000 w. Ir Age—Nov. 16, 1905. No. 73146.

Furnace Gas.

An Improved Device for Cleaning and Cooling Blast Furnace Gas (Ein Neuer Reinigungs und Kühlapparat für Hochofengase). F. Krull. A description of the Bian apparatus, in which the gas is passed through perforated discs revolving in a closed cylindrical tank containing water. 1200 w. Glückauf—Oct. 28, 1905. No. 73340 D.

Furnace Hoist.

Electrical Blast Furnace Hoist. Illus-

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trates and describes a plant at work in Germany. 1600 w. Engr, Lond—Nov. 10, 1905. No. 73296 A.

Grinding.

Grit Mills and Pans. Gives results of a series of trials between the grit mill and grinding pans at the Ivanhoe Gold Corporation, Kalgoorlie (W. A.). 2400 w. Aust Min Stand—Oct. 18, 1905. No. 73276 B.

Heat Treatment.

See Mechanical Engineering, Materials.

Hematite.

Occurrence of Hematite North of Little Current, Georgian Bay. S. Dillon-Mills. Describes the geology of the region, the minerals found, and discusses the chances for making the mining a financial success. Ills. 2200 w. Can Min Rev—Nov., 1905. No. 73200 B.

Iron Ore.

The Great Deposit of Iron Ore at Parapara, New Zealand. James MacIntosh Bell. An illustrated article describing extensive deposits of hematite ore. 1200 w. Ir Trd Rev—Nov. 23, 1905. No. 73413.

Iron Industry.

See Industrial Economy.

Manganese.

Manganese in Iron and Steel. A. A. Read. A comparison of some methods for the determination of manganese in iron and steel. 900 w. Engng—Oct. 27, 1905. No. 73008 A.

Open Hearth.

The Bertrand-Thiel Open Hearth Steel Process (Le Procédé Bertrand-Theil pour la Fabrication de l'Acier sur Sole). A general account of the double-furnace process, with details of the practical results at Kladno. 2500 w. Génie Civil—Nov. 4, 1905. No. 73317 D.

Ore Supply.

The Iron Ore Supply of the World. Interesting data from reports of Prof. Törnebohm to the Swedish Parliament, and of other reports by experts. Map. 2500 w. Ir Age—Nov. 2, 1905. No. 72936.

Rail Mill.

The Republic Iron and Steel Company's Rail Mill. Illustrated description of a mill at Youngstown, Ohio, where conditions compelled unusual engineering skill. 1500 w. Ir Age—Nov. 9, 1905. No. 73052.

Sampling.

Cargo Sampling of Iron Ores at Lake Erie Ports. W. J. Battle & Son. Read at meeting of the L. Sup. Min. Inst. Explains how samples are taken, advocating large samples, and giving the methods of analysis used. 2500 w. Ir Age—Nov. 2, 1905. No. 72937.

Silicon.

The Microstructure of Silicon and Alloys Containing Silicon. A. B. Albro. An illustrated report of investigations made under the direction of Henry Noel Potter. 1800 w. Elec, Chem & Met Ind—Nov., 1905. Serial. 1st part. No. 73072 C.

Spanish Mines.

The Alquife Iron-Ore Mines, in the South of Spain. George Harley Bulmer. Describes these mines and their working. 1000 w. (No. 3496.) Inst of Civ Engrs. No. 73164 N.

The Iron Ore Deposits of Spain (Der Eisenerzreichtum Spainens). Oskar Simmersbach. A review of the valuable iron ore beds of Spain, with chemical analyses, and tabulated data concerning exports. 3500 w. Glückauf—Nov. 4, 1905. No. 73341 D.

MINING.

Boring.

Improved Boring Appliances Shown at the Liége Exposition (Neue Bohrapparate auf der Lütticher Weltausstellung). Fritz Krull. Describing especially the Wolski hydraulic rock drill, and the Frieh & Nollenburg system for sinking shafts. 2000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Oct. 21, 1905. No. 73343 D.

The Recovery of a Diamond Crown from a Deep Bore-hole. Cuthbert Baring Horwood. Describes a recovery from a depth of 3,233 feet. Ills. 800 w. (No. 3473.) Inst of Civ Engrs. No. 73168 N.

Cableways.

The Aërial Tramways at the Silver Cup Mine. George Attwood. Abstract of a paper in *Pro. of the Inst. of Civ. Engrs.* Illustrates and describes four tramways for conveying mining and food supplies, mining timbers and firewood, as well as passengers. 1600 w. Eng & Min Jour—Nov. 4, 1905. No. 73019.

Concentration.

Concentrating in the Western Kentucky District. Abstract of a paper read by F. Julius Fohs, at Marion, Ky., in regard to the problem of separating fluor spar from lead and zinc ores. 1500 w. Mines & Min—Nov., 1905. No. 73035 C.

Death Valley.

Notes on Death Valley and the Panamint. George D. James. An illustrated account of a trip to this region. Map. 3000 w. Eng & Min Jour—Nov. 18, 1905. No. 73238.

Drainage.

Drainage of the Cripple Creek District. D. W. Brunton. A report prepared for a committee appointed by Cripple Creek

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mine owners, giving interesting information concerning the tunnels, their cost, location, etc. Ills. 4500 w. Eng & Min Jour—Nov. 4, 1905. No. 73018.

Dredge.

An Improved Dipper Dredge. F. F. Coleman. Illustrated description of a new dipper dredge made by the Allis-Chalmers Company. 1000 w. Eng & Min Jour—Nov. 25, 1905. No. 73450.

Drilling.

Recent Improvements in Core Drilling Without Diamonds. Lucius I. Wightman. Briefly describes the Davis system, and improvements added. Ills. 1200 w. Eng & Min Jour—Nov. 4, 1905. No. 73022.

Egypt.

Mining and Use of Metals by the Ancient Egyptians. Prof. R. D. George. Information on this subject gathered from many sources. 7000 w. Pop Sci M—Dec., 1905. No. 73419 C.

Electric Power.

Improvements in Electric Operation of Coal Mines. George E. Walsh. An account of the operation of the mines in the vicinity of Scranton and Wilkesbarre, where electricity is generated at a central station and distributed for mine operation. 2200 w. Min Wld—Nov. 25, 1905. No. 73472.

See Electrical Engineering, Distribution.

Exposition.

Mining at the Liége Exposition (Der Bergbau auf der Lütticher Weltausstellung). F. Herbst. An extended descriptive and critical review of the mining appliances and methods shown at the exposition. Serial. Part I. 4000 w. Glückauf—Oct. 21, 1905. No. 73338 D.

Management.

A Puncher Machine Mine. Charlton Dixon. Discusses some of the difficulties of management and their causes, with suggestions for obtaining the greatest efficiency of plant. 5000 w. Mines & Min—Nov., 1905. No. 73039 C.

Mexico.

Geology of Sonora, Mexico. F. J. H. Merrill. Information concerning the geological formations. 1200 w. Eng & Min Jour—Nov. 25, 1905. No. 73451.

Mica.

Mica. Phillips Thompson. A description of a monograph on mica, by Fritz Cirkel, with information from this source. 2000 w. Eng & Min Jour—Nov. 4, 1905. No. 73021.

Mining.

Legitimate and Illegitimate Mining. Thomas Tonge. Abridged report of an address before the Students' Technical Society of the Colorado School of Mines. 4500 w. Min Jour—Nov. 11, 1905. No. 73285 A.

Mining Methods.

Coal Mining Methods. The characteristics of the deposits, which determine the method of mining, are described; the room-pillar and long-wall systems and their modifications, stating the conditions favoring long-wall mining. 2000 w. Eng & Min Jour—Nov. 18, 1905. No. 73242.

Mining Properties.

Examining Mining Properties. Prof. Arthur Lakes. Suggestions as to methods of proceeding and facts to be included in reports on properties. Ills. 1600 w. Mines & Min—Nov., 1905. No. 73037 C.

Orebodies.

Large Orebodies in Australia—Mining Methods. A. Selwyn Brown. A brief sketch of some of the more important methods adopted. 1500 w. Eng & Min Jour—Nov. 25, 1905. No. 73447.

Prospecting.

Churn-Drill Prospecting. George C. McFarlane. Illustrates and describes a gas-pipe churn-drill, cutting a 2 or a 2½-in. hole, useful in prospecting to moderate depths, where the country rock is not especially hard. 2000 w. Eng & Min Jour—Nov. 18, 1905. No. 73239.

Pumping.

Electric Pumping at Collieries. Gerald Hooghwinkel. Abstract of a paper read before the Manchester Geol. & Min. Soc. Considers the types of pumps, the electric motors, efficiency, and electric sinking pumps. 4000 w. Col Guard—Nov. 17, 1905. No. 73481 A.

Pyrite.

A Noted Pyrite Deposit. W. H. Storms. An account of the occurrence of sulphide ore in Whizzers mine, at Deadwood, S. D. 1200 w. Min & Sci Pr—Oct. 28, 1905. No. 73050.

Safety Lamps.

Recent Experiments on Safety Lamps (Nouvelles Expériences sur les Lampes de Sureté). H. Schmerber. Describing the appliances and results at the testing station at Frameries, Belgium. The lamps are exposed to explosive gases drawn from the mines. Two articles. 3000 w. Génie Civil—Oct. 21, 28, 1905. No. 73-312 each D.

Shafts.

Noteworthy Shaft Sinking at Detroit. An account of conditions that made the work very difficult, and the final success in sinking a shaft, where for 20 years every attempt had proved a failure. 1200 w. Ir Age—Nov. 16, 1905. No. 73147.

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Mine Surveying. C. A. S. Andrews. Read at meeting of the Queensland Inst. of Surveyors. Detailed description of the method the writer has found to be best for an underground survey. 2500 w. Queens Gov Min Jour—Sept. 15, 1905. Serial. 1st part. No. 72974 B.

Surveying Secondary Mine Openings. Floyd L. Burr. Read before the L. Sup. Min. Inst. A brief description of a method used by the writer, and as accurate as is necessary for the work for which it is used. 1000 w. Eng & Min Jour—Nov. 11, 1905. No. 73103.

Switchgear.

Colliery and Mining Switchgear for High and Low Tension Alternating Current Service. A. M. Randolph. Describes a special line of switchgear and control apparatus for use in connection with mining operations. 1400 w. Elec Rev, Lond—Nov. 3, 1905. Serial. 1st part. No. 73128 A.

Unwatering.

Unwatering of the Achddu Colliery. John Morris. Abstract of a paper read before the Inst. of Min. & Met. Gives an account of the work, describing the pumps used and stating the difficulties. 3000 w. Min Jour—Nov. 11, 1905. No. 73284 A.

Unwatering the Hamilton Mine. John T. Jones. Read before the L. Sup. Min. Inst. An interesting account of the work of unwatering the mines at Iron Mountain, Mich. 1200 w. Eng & Min Jour—Nov. 11, 1905. No. 73104.

Utah.

Mineral Resources of Uintah Reservation. William S. Smith. Information concerning the deposits of this region in Utah. Copper, silver and lead and valuable deposits of the hydrocarbons. Map. 1000 w. Min Wld—Nov. 4, 1905. No. 73043.

Veins.

Fissure-Veins. R. W. Raymond. A contribution to a discussion of the question, What is a fissure-vein? 1200 w. Eng & Min Jour—Nov. 25, 1905. No. 73446.

Winding Engine.

New Winding Engine at the Sacré Madame Mines, Belgium (Nouvelle Machine d'Extraction à Vapeur des Charbonnages de Sacré-Madame, Belgique). L. Ramakers. Illustrating a double horizontal winding engine shown at the Liége exposition. 1500 w. 1 plate. Génie Civil—Nov. 11, 1905. No. 73318 D.

MISCELLANY.

Asbestos.

Asbestos in Canada. Abstract of a monograph recently published by the Mines Bureau of the Dominion, giving information concerning the valuable deposits in Quebec. Ills. 1400 w. Eng & Min Jour—Nov. 18, 1905. No. 73241.

Furnaces.

Heat Insulation. R. S. Hutton and J. R. Beard. Describes experiments to determine the relative value of heat-insulating materials used for the bricks or linings of furnaces. Diagrams. 1700 w. Eng Rec—Nov. 25, 1905. No. 73494.

Solutions.

Solutions of Solids and Solid Solutions. J. H. Stansbie. Abstract of paper read before the Met. Soc. at the Birmingham, Eng., Munic. Tech. School. A study of the changes which refer to the solid and liquid states of metals. 2500 w. Mech Engr—Nov. 18, 1905. No. 73454 A.

Zinc.

The Concentration and Separation of Zinc-Lead Ores as Practiced in Summit County, Colorado. Illustrates and describes a plant at Breckenridge, Colo. 800 w. Min Rept—Nov. 16, 1905. No. 73267.

The Estimation of Zinc. H. Nissenson and W. Kettembeil. Abstract of a paper in *Chemiker Zeitung*. Gives a review of the volumetric methods and a report of experiments of the authors. 3000 w. Eng & Min Jour—Nov. 25, 1905. No. 73449.

RAILWAY ENGINEERING

CONDUCTING TRANSPORTATION.

Derailments.

Unexplained Derailments. G. H. List. Gives an account of some experiences gained during 13 years of service, which offer explanations for some accidents. 1500 w. Engr, Lond—Nov. 3, 1905. No. 73134 A.

Explosives.

An Expert Report on the Transportation and Handling of Explosives by Railways. Full abstract of Dr. Charles B. Dudley's report, and of the report of the Committee of Experts. 8500 w. Eng News—Nov. 9, 1905. No. 73083.

Regulations for the Transportation of Explosives. Gives the regulations drafted by the committee of the Am. Ry. Assn. and approved at Chicago, Oct. 25, 1905. 3500 w. Eng News—Nov. 23, 1905. No. 73426.

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South Africa.

The Cape Government Railways. Abstract of a paper by A. M. Tippett, read before the British Assn. at Cape Town, which gives information in regard to the working of these lines. Ills. 1800 w. R R Gaz—Vol. XXXIX., No. 20. No. 73224.

MOTIVE POWER AND EQUIPMENT.

Air-Brakes.

Air-Brakes in Freight Train Service. Abstract of the testimony recently presented at Washington by the representatives of various railway companies opposing the proposed increase in the number of air-brakes required on freight trains. 2200 w. Eng News—Nov. 9, 1905. No. 73086.

Percentages of Freight Cars Air Braked. Information in tabulated form showing how many cars are air-braked on the different roads, and how well the trains have been air-braked during the past six months. 1000 w. R R Gaz—Vol. XXXIX., No. 19. No. 73090.

Car Lighting.

See Electrical Engineering, Lighting.

Cars.

A Combination Stock and Drop-Bottom Dump Car. Illustrates and describes a new type of 80,000-lb. stock car, intended primarily for coal or coke service when not carrying stock. 600 w. R R Gaz—Vol. XXXIX., No. 18. No. 72977.

50-Ton Steel Twin Hopper Gondola Car. Illustrates and describes cars almost entirely of structural steel, and having several departures from ordinary designs. 1,000 have been received by the L. S. & M. S. Ry. 1500 w. Am Engr & R R Jour—Nov., 1905. No. 72944 C.

Large Freight Cars (Güterwagen von Hoher Tragkraft). E. Metzeltin. With numerous illustrations of flat top, box, and hopper cars of the largest sizes in German, British, and American railway service. Serial. Part I. 3000 w. Zeitschr d Ver Deutscher Ing—Nov. 4, 1905. No. 73307 D.

New Types of Railway Rolling Stock (Quelques Nouveaux Types de Materiel de Chemins de Fer). H. Chevalier. Describing some new coaches and sleeping cars of the Western Railway of France. 2500 w. 1 plate. Mem Soc Ing Civ de France—Sept., 1905. No. 73337 G.

Steel Cars for the New York Central's Electric Suburban Service. Illustrated description of all-steel cars. 1500 w. R R Gaz—Vol. XXXIX., No. 18. No. 72978.

Draft Gears.

Friction Draft Gear. R. H. Blackall. Reviews the development, discussing the uses, advantages, cost, &c., comparing the results of twin and friction gears in service. 3000 w. 1 table and fig. Bul Int Ry Cong—Oct., 1905. No. 73403 F.

Hospital Car.

Hospital Car for the Southern Pacific. Illustrated description of a handsome special car, which is arranged for hospital service, but so constructed that it can be used as a private car. 1000 w. Ry Age—Nov. 3, 1905. No. 73047.

Locomotives.

A Lehigh & New England Rebuild. Illustrates the engine before and after rebuilding, describing the changes. 500 w. Ry & Loc Engng—Nov., 1905. No. 72934 C.

Austrian 0-10-0 Locomotive. Karl Göldsdorf. Illustrated description of a design built in 1901 for the State Railways. Also some of the most recent designs. 400 w. Ry & Loc Engng—Nov., 1905. No. 72932 C.

Bogie Tank Locomotive, Madrid and Alicante Railways. Illustrates and describes double-bogie tank engines for heavy suburban service. 400 w. Engr, Lond—Nov. 17, 1905. No. 73463 A.

British Locomotives in 1904. Charles Rous-Marten. Discusses the designs and the good locomotive work. 6200 w. Ills. Bul Int Ry Cong—Oct., 1905. No. 73402 F.

Compound Freight Locomotive (Locomotive Compound à Marchandises). F. Barbier. Describing a double motor-bogie engine of 102 tons weight designed for the heavy coal traffic of the Northern Railway of France. 2000 w. 1 plate. Génie Civil—Oct. 28, 1905. No. 73313 D.

Compound Locomotives on the Great Western Railway. A. G. Robins. An interesting account of the work of the express locomotives of the Great Western Railway, and the results of test made with engines of the de Glehn type. Ills. 4500 w. Engng—Nov. 3, 1905. No. 73130 A.

Compound Locomotives with Superheaters. Illustrated description of a compound consolidation freight locomotive with superheater, for the Minneapolis, St. Paul & Sault Ste. Marie Ry. 1200 w. Eng News—Nov. 23, 1905. No. 73420.

Consolidation Locomotive for the Imperial Government of Japan. Illustrates the 2-8-6 type of locomotive, a number of which have been built in America for Japan. 500 w. Ry & Loc Engng—Nov., 1905. No. 72931 C.

Engine Equipments. R. Emerson. Gives a representative list of the appurtenances and appliances, discussing how to improve conditions, the cost of installing a new system, the method, &c. 3500 w. Am Engr & R R Jour—Nov., 1905. No. 72946 C.

We supply copies of these articles. See page 639.

Four-Cylinder Compound Freight Locomotive for the Swiss Railways (Vierzylinder Verbund Güterzug Lokomotive der Schweizerischen Bundesbahnen). M. Weiss. Illustrated description of a 66 ton counterbalanced compound engine for heavy freight service in Switzerland. 1800 w. 1 plate. Schweiz Bauzeitung—Oct. 21, 1905. No. 73332 B.

4-Cylinder Compound Locomotives in Belgium. Charles S. Lake. Reviews the tendencies of modern locomotive practice in Belgium, and gives illustrated descriptions of two heavy engines of great power recently built. 1500 w. Mech Engr—Oct. 28, 1905. No. 72995 A.

Four-Cylinder Express Locomotive for the London and South-Western Railway. Illustrated detailed description of a new and interesting engine designed by Mr. Drummond. 1000 w. Engng—Nov. 10, 1905. No. 73291 A.

4-6-0 Engine for the D., L. & W. Illustration and description of recently completed passenger engines designed to burn fine anthracite coal. 600 w. Ry & Loc Engng—Nov., 1905. No. 72928 C.

Heavy Duplex Compound Goods Locomotive. Photograph and sectional elevation, with description of one of two heavy articulated compound locomotives designed by Mons. de Bosquet, of the Northern Ry. of France. 900 w. Prac Engr—Oct. 27, 1905. No. 72992 A.

Heavy Ten-Wheel Passenger Locomotive for the Delaware, Lackawanna & Western R. R. Illustration, dimensions and brief description of a heavy (4-6-0) passenger engine. 500 w. R R Gaz—Vol. XXXIX., No. 20. No. 73230.

Performance of a Balanced Compound Locomotive, A. T. & S. F. Ry. Illustration, with report of very satisfactory work. 800 w. Ry & Engng Rev—Nov. 4, 1905. No. 73049.

Peter Cooper's Locomotive. A brief account of one of the earliest locomotives in America, running from Baltimore to Ellicott's Mills in 1830. 400 w. Ry & Loc Engng—Nov., 1905. No. 72927 C.

Six-Coupled Express Engines on the London & North-Western Railway. Charles Rous-Marten. Describes the latest locomotive designed for the express service of this road, explaining the difficult conditions between Crewe and Carlisle. 4500 w. Engr, Lond—Nov. 10, 1905. No. 73292 A.

The Steam Locomotive. J. K. Brassill. An illustrated review of its evolution and development as evidenced by the exhibits in the transportation building at the St. Louis World's Fair. 18500 w. Pro Pacific C Ry Club—Oct. 21, 1905. No. 72926 C.

Two Baldwin Four-Cylinder Balanced Compound Locomotives. Illustrated descriptions of two new types. An Atlantic (4-4-2) type engine, and a Pacific (4-6-2) engine. 500 w. R R Gaz—Vol. XXXIX., No. 19. No. 73088.

Vauclain 4-Cylinder Balanced Compound Atlantic Type Locomotive. Illustrated description of locomotives recently built for the C., R. I., & P. Ry. 400 w. Am Engr & R R Jour—Nov., 1905. No. 72947 C.

Repairs.

The Cost of Locomotive Repairs per 1,000-Ton Miles. Harrington Emerson. Does not consider it safe to generalize under existing conditions, suggesting the best way to cheapen engine repairs. 700 w. Am Engr & R R Jour—Nov., 1905. No. 72945 C.

Train.

South-Eastern & Chatham Express Train. Engraving and description of a fine British express train. 900 w. Loc Engng—Nov., 1905. No. 72930 C.

Valve Gears.

History of the Walschaerts Valve Motion. M. J. Boulvin. Translated from *Revue de Mécanique*. Ills. 1500 w. R R Gaz—Vol. XXXIX., No. 21. No. 73435.

NEW PROJECTS.

China.

Railroad Development in China. John Foord. Discusses the importance of Japan's victory over Russia in its effect upon China, and reviews the history of railroad building, and the present attitude of China toward the construction of railroads. Map. 4000 w. Ir Age—Nov. 23, 1905. No. 73400.

Cyprus.

Cyprus Government Railway. Outlines the history of this island of the Mediterranean and gives a map and description of the railway under construction, with illustrations, of the interesting features. 1800 w. Engr, Lond—Nov. 17, 1905. No. 73464 A.

Korea.

Opening Korea by Rail. Homer B. Hulbert. An illustrated account of the building of the Seoul-Fusan line, and the difficulties encountered. 3000 w. World's Work—Nov., 1905. No. 72921 C.

New Road.

A Feat in Railroad Building. Lawrence Lewis. An illustrated account of the "air line" from Denver to Salt Lake City, being built by D. H. Moffat, of Denver, Colo. It has 29 tunnels in 11 miles, with wonderful engineering work. 3400 w. World's Work—Nov., 1905. No. 72922 C.

We supply copies of these articles. See page 639.

Railroad Development.

The "Deepwater-Tidewater" Railroads. George W. Harris. Map and account of a system to extend from the head of navigation on the Kanawha River, to tidewater at Hampton Roads. 1200 w. Eng & Min Jour—Nov. 4, 1905. No. 73020.

PERMANENT WAY AND BUILDINGS.

China.

Railway Construction in North China. Edward Hulme Rigby and William Orr Leitch, Jr. A description of the Chinchou-Yingkow section, 97 miles in length. Ills. 18000 w. (No. 3509.) Inst of Civ Engrs. No. 73156 N.

Crossings.

A Graphical Method of Determining the Relative Positions of Points and Crossings. Charles John Albrecht. Brief description of method. 600 w. (No. 3489.) Inst of Civ Engrs. No. 73167 N.

New South Wales.

Early Railway Construction in New South Wales. Joseph Brady. Brief account of work from 1850 to 1857. 1800 w. (No. 3467.) Inst of Civ Engrs. No. 73158 N.

Retaining Wall.

Concrete Retaining Wall of the Illinois Central on the Lake Front, Chicago. Illustrations and description of the east wall now under construction, with outline of work previously completed. 1000 w. R R Gaz—Vol. XXXIX., No. 20. No. 73225.

Shops.

East Moline Locomotive Shops. Begins an illustrated detailed description of these five repair shops of the Rock Island system. 3000 w. Am Engr & R R Jour—Nov., 1905. Serial. 1st part. No. 72943 C.

Electric Drive in Locomotive Repair Shops. A. S. Atkinson. Describes the electric drive in the large car shops of the Buffalo, Rochester & Pittsburgh Ry. Co. at Du Bois, Pa., giving details of operation and results obtained. 2500 w. Ry & Loc Engng—Nov., 1905. No. 72929 C.

Signaling.

An English Electric System of Railway Signaling. F. C. Perkins. An illustrated description of the Webb & Thompson electric point and signal apparatus installed on the London & Northwestern Railway. Shows the devices used in one of the signal cabins at Crewe, which will contain more than 1,000 levers. 1800 w. Sci Am Sup—Nov. 11, 1905. No. 73093.

Terminals.

Electric Equipment and Reconstruction of the New York Terminal Lines and Grand Central Station, New York Central & Hudson River R. R. A finely illustrated article summarizing this great work now in progress which is to cost about $60,000,000. 12000 w. Eng News—Nov. 16, 1905. No. 73218.

Improvements of the New York Central & Hudson River Within the Electric Zone. G. R. Wadsworth. Illustrates and describes the Marble Hill cut-off, the Port Morris Branch depression, elimination of grade crossings and special station improvements, and the four-tracking of the Hudson and Harlem divisions. 2000 w. R R Gaz—Vol. XXXIX., No. 19. No. 73087.

Terminal Yard Improvements of the New York Central & Hudson River R. R. Briefly outlines the conditions at this terminal before the commencement of improvements, and gives an illustrated account of the extensive work in progress. 3000 w. Eng Rec—Nov. 18, 1905. No. 73247.

The Marble Hill Cut-Off and Port Morris Branch, New York Central Terminal Improvements. Gives a general review of the conditions at the New York terminal of the N. Y. C. & H. R. R. R., and within the territory to be operated by electricity, describing this enormous engineering undertaking which will approximate $60,000,000 in cost. Ills. 5000 w. Eng Rec—Nov. 4, 1905. No. 73061.

The New Weehawken Railroad Terminal Power Plant. Illustrated detailed description of an electric plant for the operation of the grain elevators, shops, &c., and the lighting of the large terminal yard and buildings of the West Shore R. R. 4500 w. Eng Rec—Nov. 11, 1905. No. 73145.

Track Elevation.

Kinzie Street Track Elevation of the Chicago & North-Western, Chicago. An illustrated description of an interesting piece of work with difficult features. 2000 w. R R Gaz—Vol. XXXIX., No. 19. No. 73089.

Transition Curves.

Setting Out and Checking Circular and Transition Curves in Railway Track. Illustrated description of a simple instrument, designed by F. A. Smith, by which the section foreman can check the accuracy of his curves. 1600 w. Eng News—Nov. 16, 1905. No. 73221.

Transition Curves on the Southern Pacific R. R. An explanation of methods employed by the engineering department of this road, illustrated by example. Diagram and tables. 1400 w. Eng Rec—Nov. 11, 1905. No. 73140.

Tunnels.

See Civil Engineering, Construction.

We supply copies of these articles. See page 639.

Water Tanks.

Protecting Railway Water Tanks from Freezing. Presents the available means of protecting water tanks as given in a committee report made to the Assn. of Ry. Supts. of Bridges & Bldgs. Ills. 1500 w. Eng News—Nov. 2, 1905. No. 72956.

Wilmington.

Pennsylvania Improvements at Wilmington, Del. Illustrates and describes extensive improvements, including a brick arched viaduct, massive stone retaining walls, plate girders, drawbridge, changes of track, a new passenger station and office building, etc. 2500 w. Ry Age—Nov. 3, 1905. No. 73048.

Yardmaster.

The Work of a Yardmaster. J. D. Tyler. Read before the New England R. R. Club. Discusses the qualifications and training needed and the character of the work. 2200 w. Ry & Engng Rev—Nov. 18, 1905. No. 73268.

TRAFFIC.

Clearing House.

Early Proposals to Form a Clearing House in Connection with Trunk Line Associations. J. W. Midgley. Reviews the various schemes for establishing a railway clearing house, explaining the views of various railway men. 5000 w. Ry Age—Nov. 10, 1905. No. 73102.

Freight.

Handling Fast Freight in England. An account of the extravagant development of this type of traffic in England. 2000 w. R R Gaz—Vol. XXXIX. No. 21. No. 73431.

Handling Freight so as to Avoid Losses. Extracts from an address on loss and damage and its effects upon railroad revenue, delivered to the freight agents of the N. Y. C. & H. R. R., by R. L. Calkins. 2200 w. R R Gaz—Vol. XXXIX. No. 19. No. 73091.

Time Freight on the Erie. Describes the system of handling and keeping a record of the movement of fast freight. The principle on which it is based is the grouping of cars containing freight of similar classification from one point to another point and making one manifest for the group of cars. 2000 w. R R Gaz—Vol. XXXIX. No. 20. No. 73227.

Locomotive Loading.

Loading of Locomotives on the Equated Tonnage of Drawbar-Pull Basis. J. M. Daly. Discusses the proper method of rating and loading locomotives, giving illustrated description of a computing device that automatically registers the number of cars in train and adjusts the drawbar-pull of each gross weight of car at each location in the train. Lengthy discussion of interest. 15500 w. Pro N Y R R Club—Oct. 20. 1905. No. 73409.

Ton-Mile.

Ton-Mile Railway Statistics, and Railway Rates and Terminal Charges. R. Price-Williams. Gives a tabular statement showing the value of the ton-mile principle as applied to ascertaining goods and mineral traffic receipts, with discussion of this and related subjects. 1500 w. Ir & Coal Trds Rev—Oct. 27, 1905. No. 73012 A.

MISCELLANY.

England.

Work of the English Railway and Canal Commission. Abstract of a paper by S. J. McLean in the *Quarterly Jour. of Economics*. Reviews the actual results obtained during the last 17 years by a body possessing many of the functions proposed for the Interstate Commerce Commission. 2500 w. R R Gaz—Vol. XXXIX. No. 21. No. 73436.

Railway Congress.

Official Information Issued by the Permanent Commission of the Railway Congress. Summary of the proceedings of the seventh session at Washington, D. C., 1905. 12600 w. Tables. Bul Int Ry Cong—Sept., 1905. No. 73401 H + F.

STREET AND ELECTRIC RAILWAYS

Apparatus.

Selection and Operation of Street Railway Apparatus. A. G. Rakestraw. The present article considers motors, trucks, gears, and methods of control. 3000 w. Sib Jour of Engng—Oct., 1905. Serial. 1st part. No. 73487 C.

Boston Elevated.

New Power-Station Equipment of the Boston Elevated Railway Company. Illustrates and describes equipment which will increase the present power supply 10 per cent. It includes a d. c. 2000-kw. turbo generator outfit to be added to the Dorchester station, a 875-kw. gas engine plant at Salem St. station, Medford; and a 700-kw. gas-engine plant for W. Somerville. 3000 w. St Ry Jour—Nov. 4, 1905. No. 73025 C.

We supply copies of these articles. See page 639.

Bournemouth.

Electric Traction at Bournemouth. Illustrates and describes a combined conduit and trolley system with extensions in three boroughs. 2800 w. Tram & Ry Wld —Nov. 9, 1905. No. 73492 B.

Cars.

The Standard Surface Car of the Brooklyn Rapid Transit Company. Illustrated detailed description of a car recently adapted for service in surface lines, which is quite a departure from the usual type of semi-convertible cars. 2000 w. St Ry Jour—Nov. 18, 1905. No. 73234 C.

Car Works.

Manchester Tramway Car Works. Brief illustrated description of a recently completed works in England. 1000 w. Tram & Ry Wld—Nov. 9, 1905. No. 73491 B.

Depot.

Burnley Tramways Depot. Henry Mozley. Particulars and illustrations of the Queens' Gate depot and general offices which have recently been erected, equipped and placed in operation. 2000 w. Tram & Ry Wld—Nov. 9, 1905. No. 73490 B.

Electric Traction.

Development of Heavy Electric Traction. Discusses the subject as applicable to suburban service, favoring single-phase traction not only for long-distance lines, but for heavy suburban traffic. 1500 w. Elec Rev, Lond—Nov. 17, 1905. No. 73456 A.

Electric Traction. (Question VIII, 7th Session.) Victor Tremontani. Appendices to the report No. 4. Deals with accumulators, continuous current motors, three-phase current motors, monophase current motors, etc. 22300 w. 6 tables and Ills. Bul Int Ry Cong—Oct., 1905. No. 73404 F.

Heavy Electric Railroading. Bela Valatin. A comparison of the direct current, the single-phase, and the three-phase systems, particularly for installations to be used for moving heavy train units, and where electricity is to replace the steam locomotive. 3000 w. Elec Wld & Engr—Nov. 18, 1905. No. 73245.

Electrification.

Electrification of the Long Island Railroad. S. D. V. Burr. Map and illustrated description of the extensive system of electrification recently completed. 2500 w. Ir Age—Nov. 2, 1905. No. 72935.

Electrification of the New York Suburban District of the New York Central & Hudson River Railroad. Illustrated descriptions of the power stations at Yonkers and at Port Morris, and of a typical sub-station, and their equipment and operation. 3800 w. Elec Rev, N Y—Nov. 11, 1905. No. 73113.

Improvements of the New York Central & Hudson River Within the Electric Zone. G. R. Wadsworth and J. C. Irwin. The present article gives an illustrated description of the electrical equipment. 5000 w. R R Gaz—Vol. XXXIX. No. 20. No. 73226.

Improvements of the New York Central and Hudson River Within the Electric Zone. G. R. Wadsworth. This article concludes a series, and describes and illustrates the new terminal building which will be erected on the site of the Grand Central Station. 1300 w. R R Gaz—Vol XXXIX. No. 21. No. 73433.

New York Central Electrification. Illustrates and describes the improvements which are in progress at the Forty-second Street terminal in New York City, to accommodate electric trains, and also the transmission system and sub-stations. 4200 w. St Ry Jour—Nov. 18, 1905. No. 73235 C.

Power Stations of the Electric Zone of the New York Central & Hudson River Railroad. Illustrates and describes the stations at Yonkers and Port Morris, with a typical sub-station and its equipment. 4000 w. St Ry Jour—Nov. 11, 1905. No. 73119 C.

The Electrification of the Long Island Railroad. An illustrated description of this important electrification of a steam road, and the complicated service. 4000 w. Eng Rec—Nov. 4, 1905. No. 73058.

The Electrification of the Long Island Railroad. Illustrates and describes the main features of this important installation. 3800 w. St Ry Jour—Nov. 4, 1905. No. 73024 C.

The Installation of Electric Traction on the Long Island R. R. An illustrated article giving a statement of the work thus far done. 4000 w. Eng News—Nov. 2, 1905. No. 72954.

English Practice.

English Electric Railway Practice. Particulars regarding features of recent permanent way and conductor rail work on roads changed from steam to electric traction. Ills. 2300 w. Prac Engr—Nov. 3, 1905. No. 73124 A.

Interurban.

Freight and Express Traffic on Interurban Railways. M. E. Graston. Read before the Indiana Elec. Ry. Assn. Discusses points in regard to increasing the business and handling the freight. Abstract of discussion. 2800 w. St Ry Rev—Nov. 15, 1905. No. 73212 C.

We supply copies of these articles. See page 639.

Locomotive.

A Storage-Battery Locomotive. Illustrated description of a novel type of electric locomotive designed for service on the new drop level tube for London that is in course of construction. 700 w. Sci Am—Nov. 25, 1905. No. 73414.

Loops.

Traffic Problems Upon Loops and Stub Tracks. Howard S. Knowlton. Presents equations covering the general cases most commonly encountered. 2700 w. St Ry Rev—Nov. 15, 1905. No. 73211 C.

Mono-Rail.

The Wetterhorn Electric Aerial Mono-Rail. A departure in mountain railway construction is illustrated and described. A stout wire cable forms the overhead mono-rail from which is suspended the running gear of the car body. 1000 w. Engr, Lond—Nov. 10, 1905. No. 73299 A.

N. Y. Subway.

The Sanitary Condition of the New York Rapid Transit Subway. Gives a reprint of the preliminary report of Dr. George A. Soper, with editorial comment. 2800 w. Eng News—Nov. 9, 1905. No. 73085.

Railway Test.

Test of the Railway System of the Scioto Valley Traction Company. F. C. Caldwell. The principal object of the test was to obtain a statement of the distribution of the power consumption and losses throughout the system during a normal day's run. 4800 w. St Ry Rev—Nov. 15, 1905. No. 73210 C.

Reconstruction.

The Reconstruction of the Topeka Railway. An account of a thorough reconstruction of the physical equipment, and reorganization of operating methods which brought such an increase in net earnings as made the returns on the investment entirely satisfactory. Ills. 2700 w. St Ry Jour—Nov. 11, 1905. No. 73120 C.

Single-Phase.

Single-Phase Electric Traction (La Traction Electrique par Courant Alternatif Simple). Describing the Auvert-Ferrand transformer for use directly upon the car. 1500 w. Génie Civil—Nov. 11, 1905. No. 73320 D.

Tests of Interurban Single-Phase Equipments. Graham Bright. Describes methods of testing, reporting tests taken recently. 1500 w. Elec Jour—Nov., 1905. No. 73406.

Snow.

Novel Swiss Combination Snow-Plow and Sweeper. Illustrated description of an efficient apparatus for the removal of snow. 500 w. St Ry Jour—Nov. 4, 1905. No. 73026 C.

Stray Current.

See Civil Engineering, Municipal.

Subway.

Proposed Subway in Berlin (Entwurf von Unterpflasterbahnen in Berlin). Plans for shallow subways in the central portion of the city, with map. 2500 w. Elektrotech Zeitschr—Oct. 26, 1905. No. 73352 B.

Surface Contact.

Surface Contact Systems. Brief discussion of the four systems on trial in England—the Lorain, the Dolter, the G. B., and the Kingsland. Ills. 2200 w. Elec Rev, Lond—Nov. 10, 1905. No. 73280 A.

Suspension Railway.

Design for a Suspension Railway in Berlin (Entwurf einer Elektrischen Schwebebahn für Berlin). Detailed account of a rapid transit system for Berlin, similar to the Barmen-Elberfeld line. 5000 w. Elektrotech Zeitschr—Oct. 26, 1905. No. 73351 B.

Switzerland.

The Sernf Valley Railway (Die Sernftalbahn). Illustrated description of the electric railway recently opened in the Sernf valley between Schwanden and Elm, above Glarus, Switzerland. Serial. Part I. 1500 w. Schweiz Bauzeitung—Nov. 11, 1905. No. 73333 B.

The Electric Railway of Gruyères. Emile Guarini. Illustrated description of a recent line in the canton of Freiburg, Switzerland. 2000 w. Engineering Magazine—Dec., 1905. No. 73377 B.

Topeka.

Topeka Railway Company. An illustrated description of the roadbed, shops, equipment, generating station and park. 4000 w. St Ry Rev—Nov. 15, 1905. No. 73209 C.

Wellington, N. Z.

Wellington City Tramways. An illustrated article describing the recent extensions and electrification of the tramway lines in this city of New Zealand. 4000 w. Tram & Ry Wld—Nov. 9, 1905. No. 73489 B.

Wheel-Shop.

New Wheel-Shop of the New York City Railway Company. States the peculiar conditions which make the wheel problem a matter of great importance in New York, and gives an illustrated description of the new shop and its equipment. 2000 w. St Ry Jour—Nov. 25, 1905 No. 73452 C.

We supply copies of these articles. See page 639.

EXPLANATORY NOTE—THE ENGINEERING INDEX.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed in the preceding pages, *in the original language*, together with all accompanying illustrations; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20 cts. The letter A, B or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; H, of $1.60. When the letter N is used it indicates that copies are not readily attainable, and that particulars as to price will be supplied on application. Certain journals, however, make large extra charges for back numbers. In such cases we may have to increase proportionately the normal charge given in the Index. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *t-m*, a tri-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the index are: Ill—Illustrated; W—Words; Anon—Anonymous.

American Architect. *w.* New York.
American Electrician. *m.* New York.
Am. Engineer and R. R. Journal. *m.* New York.
American Jl. of Science. *m.* New Haven, U.S.A.
American Machinist. *w.* New York.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. d Soc. d Ing. e d Arch. Ital. *w.* Rome.
Architect. *w.* London.
Architectural Record. *m.* New York.
Architectural Review. *s-q.* Boston.
Architect's and Builder's Magazine. *m.* New York.
Australian Mining Standard. *w.* Melbourne.
Autocar. *w.* Coventry, England.
Automobile. *m.* New York.
Automobile Magazine. *m.* New York.
Automotor Journal. *w.* London.
Beton und Eisen. *qr.* Vienna.
Boiler Maker. *m.* New York.
Brit. Columbia Mining Rec. *m.* Victoria, B. C.
Builder. *w.* London.
Bull. Am. Iron and Steel Asso. *w.* Phila., U. S. A.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington.
Bull. Soc. Int. d Electriciens. *m.* Paris.
Bulletin of the Univ. of Wis., Madison, U. S. A.
Bulletin Univ. of Kansas. *b-m.* Lawrence.
Bull. Int. Railway Congress. *m.* Brussels.
California Jour. of Tech. *m.* Berkeley, Cal.
Canadian Architect. *m.* Toronto.
Canadian Electrical News. *m.* Toronto.
Canadian Engineer. *m.* Toronto and Montreal.
Canadian Mining Review. *m.* Montreal.
Cassier's Magazine. *m.* New York and London.
Cement. *b-m.* New York.
Cement Age. *m.* New York.
Central Station. *m.* New York.

Chem. Met. Soc. of S. Africa. *m.* Johannesburg.
Colliery Guardian. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad.des Sciences. *w.* Paris.
Consular Reports. *m.* Washington.
Deutsche Bauzeitung. *b-w.* Berlin.
Domestic Engineering. *m.* Chicago.
Eisenbahntechnische Zeitschrift. *b-m.* Berlin.
Electrical Engineer. *w.* London.
Electrical Magazine. *m.* London.
Electrical Review. *m.* London.
Electrical Review. *w.* New York.
Electrical World and Engineer. *w.* New York.
Electric Journal. *m.* Pittsburg, Pa.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w.* London.
Electricity. *w.* New York.
Electrochemical and Met. Industry. *m.* New York.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Chicago.
Engineering. *w.* London.
Engineering and Mining Journal. *w.* New York.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Engineering Review. *m.* London.
Eng. Soc. of Western Penna. *m.* Pittsburg, U.S.A.
Far Eastern Review. *m.* Manila, P. I.
Fire and Water. *w.* New York.
Foundry. *m.* Cleveland, U. S. A.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e. d. Str. Ferr. *w.* Rome.
Glaser's Ann. f Gewerbe & Bauwesen. *s-m.* Berlin.
Ice and Refrigeration. *m.* New York.
Ingenieria. *b-m.* Buenos Ayres.
Ingenieur. *w.* Hague.
Insurance Engineering. *m.* New York.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Magazine. *m.* Cambridge, Mass.
Iron and Steel Trades Journal. *w.* London.
Iron Trade Review. *w.* Cleveland, U. S. A.
Jour. Am. Foundrymen's Assoc. *m.* New York.
Journal Asso. Eng. Societies. *m.* Philadelphia.
Journal of Electricity. *m.* San Francisco.
Journal Franklin Institute. *m.* Philadelphia.
Journal of Gas Lighting. *w.* London.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Jour. Roy. United Service Inst. *m.* London.
Journal of Sanitary Institute. *qr.* London.
Jour. of South African Assn. of Engineers. *m.* Johannesburg, S. A.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery *b-m.* Fort Monroe, U.S.A.
Jour. W. of Scot. Iron & Steel Inst. *m.* Glasgow.
Journal Western Soc. of Eng. *b-m.* Chicago.
Journal of Worcester Poly. Inst., Worcester, U.S.A.
Locomotive. *m.* Hartford, U. S. A.
Machinery. *m.* New York.
Madrid Cientifico. *t-m.* Madrid.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, U. S. A.
Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
Métallurgie. *w.* Paris.
Minero Mexicano. *w.* City of Mexico.
Mines and Minerals. *m.* Scranton, U. S. A.
Mining and Sci Press. *w.* San Francisco.
Mining Journal. *w.* London.
Mining Magazine. *m.* New York.
Mining Reporter. *w.* Denver, U. S. A.
Mittheilungen des Vereines für die Förderung des Local und Strassenbahnwesens. *m.* Vienna.
Municipal Engineering. *m.* Indianapolis, U. S. A.
Municipal Journal and Engineer. *m.* New York.
Nature. *w.* London.
Nautical Gazette. *w.* New York.
New Zealand Mines Record. *m.* Wellington.
Oest. Wochenschr. f. d. Oeff. Baudienst. *w.* Vienna.
Oest. Zeitschr. Berg- & Hüttenwesen. *w.* Vienna.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Pro. Canadian Soc. Civ. Engrs. *m.* Montreal.
Proceedings Engineers' Club. *qr.* Philadelphia.
Pro. Pacific Coast Rwy. Club. *m.* San Francisco.
Pro. St. Louis R'way Club. *m.* St. Louis, U. S. A.
Pro. U. S. Naval Inst. *qr.* Annapolis, Md.
Public Works. *qr.* London.
Quarry. *m.* London.
Queensland Gov. Mining Jour. *m.* Brisbane, Australia.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago.
Railway & Engineering Review. *w.* Chicago
Railway and Loc. Engng. *m.* New York.
Review of Reviews. *m.* London & New York.
Revista d Obras. Pub. *w.* Madrid.
Revista Tech. Ind. *m.* Barcelona.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Gen. des Sciences. *w.* Paris.
Revue Industrielle. *w.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines. *m.* Liége.
Rivista Gen. d Ferrovie. *w.* Florence.
Rivista Marittima. *m.* Rome.
Schiffbau. *s-m.* Berlin.
Schweizerische Bauzeitung. *w.* Zürich.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Sibley Jour. of Mech. Engng. *m.* Ithaca, N. Y.
Stahl und Eisen. *s-m.* Düsseldorf.
Stevens' Institute Indicator. *qr.* Hoboken, U.S.A.
Street Railway Journal. *w.* New York.
Street Railway Review. *m.* Chicago.
Tijds v h Kljk. Inst. v Ing. *qr.* Hague.
Traction and Transmission. *m.* London.
Tramway & Railway World. *m.* London.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Trans. Inst. of Engrs. & Shipbuilders in Scotland, Glasgow.
Transport. *w.* London.
World's Work. *m.* New York.
Yacht. *w.* Paris.
Zeitschr. d. Mitteleurop. Motorwagen Ver. *s-m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutscher Ing. *w.* Berlin.
Zeitschrift für Elektrochemie. *w.* Halle a S.
Zeitschr. f. Elektrotechnik. *w.* Vienna.